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THE NEW CODE, 1871.

THE

USEFUL KNOWLEDGE
READING BOOKS

ADAPTED TO

THE USE OF BOARD-SCHOOLS AND
OTHERS UNDER GOVERNMENT INSPECTION.

BY THE

REV. E. T. STEVENS, B.A.
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EDITORS OF 'THE GRADE LESSON BOOKS' &c.

BOYS' FIFTH STANDARD.

LONDON:
LONGMANS, GREEN, AND CO.
1873.

The Editors venture to call the attention of Teachers and Managers of Schools to their

INTRODUCTORY LESSON BOOK,

embracing Reading, Writing, and Arithmetic, as preparatory to the First Standard under the New Code, 1871.

They also beg to refer to their series of

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☞ The Editors beg to draw the attention of Teachers to the notice on page viii.

ADVERTISEMENT

TO THE

FIRST EDITION

OF

USEFUL KNOWLEDGE READING BOOKS.

SERIES FOR BOYS.
SERIES FOR GIRLS.
IN SIX STANDARDS EACH.

THE EDITORS of these Series have been led to undertake their production by the fact that, for our Elementary Schools, there is an acknowledged want of books combining facility in teaching to read with the inculcation of such useful knowledge as is calculated to prepare the young to enter upon the practical duties of life with intelligent and well-furnished minds.

In attempting to produce such a work, the chief difficulty is that of supplying useful knowledge in a form sufficiently attractive, and so suited to the capacities of children as to awaken their interest and excite in them a thirst for knowledge; in truth, to effect a threefold object, namely, to teach them to read, to cultivate in their minds a love of reading, and, at the same time, to impart sound and useful instruction in those matters relating to every-day life, *for which no special times can be set apart in the daily routine of an elementary school.*

Hitherto this difficulty has seemed insuperable; and this has led to the production of books addressed almost exclusively to the imagination—the moral and emotional nature of children—to the almost total omission of subjects of practical utility.

Although it must be allowed that a very gratifying degree of success has attended the use of such books, and it cannot be wished that they should be superseded, as they certainly fulfil a very important office in the training of the children in elementary schools, the Editors believe it is generally felt by all thoughtful friends of elementary education, that the school means of training the young will be very insufficient, unless, in addition to books of this class, others be supplied which shall afford more practical information. Also, it is found in the working of a school that a double set of reading-books is very advantageous, and teachers will readily confess that the benefit derived from an occasional change of books more than counterbalances the slight additional expense which is entailed.

The great difficulty, however, which has been mentioned above, has not, as far as the Editors' knowledge extends, hitherto been overcome.

For the most part, those reading-books which aim at giving useful information to their young readers, have failed in presenting what is attractive and interesting, and adapted to the minds of children. The present Editors believe that this comparative failure may be explained partly on the ground that the books are written rather by theorists than by persons practically acquainted, as teachers, with the minds of children, and partly that the extracts are taken from writers whose ideas and language fly far above their heads; while not unfrequently too many lessons are prepared by the same hand, and thus the books acquire a monotonous and wearisome character.

A further mistake in such books has been made by the introduction of subjects involving technical teaching, which the Editors feel sure can be imparted effectually only through manuals specially treating the several subjects.

The Useful Knowledge Reading Books, therefore, aim chiefly at giving information that shall be valuable in itself, and that shall also lay a firm basis for any special technical education that may be afterwards entered upon. This foundation will best be laid by imparting to boys, whose livelihood must be drawn from the soil, some knowledge of its products and of the method of dealing with it; and by supplying, in the case of girls, as far as books can do, the immediate and indispensable need of a real and solid acquaintance with the practical matters involved in the management of a home. It is, further, obvious that much information may be given of the uses to which agricultural and mineral products may be put without entering into technicalities; and in this respect it is hoped the present series will not be found wanting.

The Editors of the Useful Knowledge Reading Books sincerely desire that they may not be misunderstood in these remarks. They make them in no captious spirit, but merely as explaining the difficulties in the way of producing a really suitable series of Useful Knowledge Reading Books; and as indicating the causes of the defects which are admitted by practical persons to prevail in most existing books of the kind.

In determining, therefore, the principles which should guide them in the production of these series, the Editors set before themselves the following points, and have done their best to carry them out:—

1. The lessons contained in the books must

impart *useful knowledge*, including in this moral teaching.

2. They must be concise, yet comprehensive.

3. They must have variety and attractiveness in style, and be level with the capacities of the children for whom they are intended.

4. They must not treat of subjects technically, technical teaching being inappropriate to such books, and above the capacities of the children for whom they are intended.

5. Looking at the fact that the pursuits and interests of girls are, for the most part, different from those of boys, although they have much in common, *it would be useful and desirable to present a series drawn up especially for girls.* (This series, the Editors hope, will be considered particularly valuable, presenting, as it does, the results of the experience and knowledge of those who, *having devoted their time and talents to the training and management of the young of their own sex*, must be peculiarly, and it may be almost said exclusively, qualified to produce lessons suited to the wants and capacities of girls.)

6. To carry out the idea, many coadjutors must be obtained specially qualified for the work.

The Editors, feeling assured that schoolmasters and schoolmistresses actually engaged in teaching the young are best qualified to write lessons calculated to interest boys and girls, and adapted to their capacities, appealed therefore to many teachers of approved ability to aid them in this important work—an appeal which, they are thankful to say, has been responded to in the best spirit; and they have great pleasure in announcing that they have been assisted in the work in hand by some of the best educated and most experienced of the trained and certificated masters and mistresses of elementary schools, and have also received the kind aid of personal friends connected with educational work. With such invaluable help, they have been able to produce two series of books—one for BOYS and another for GIRLS—which they hope will thoroughly meet the wants of the classes for whose instruction they are intended.

NOTICE TO TEACHERS.

The Committee of Council on Education now require that each School subject to Inspection shall be provided with TWO COMPLETE SETS OF READING-BOOKS, and that the children presented for examination shall show an acquaintance with the SUBJECT MATTER of the Lessons contained in their respective standards.

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THE

USEFUL KNOWLEDGE READING BOOKS.

STANDARD V. (BOYS' SERIES.)

ANTEDILUVIAN ANIMALS.[1]

an-te-di-lu′-vi-an (L. ante, diluvium), *existing before the deluge or flood*

con-tin′-u-al-ly (L. con, teneo), *unceasingly*

ex′-tinct (L. ex, stinguo), *put out, abolished, dead*

cul′-ti-vate (L. cultum), *to improve, to prepare for crops*

in-ter-fe′-rence (L. inter, fero), *a clashing, a coming between*

cor-re-spond′-ing (L. con, respondeo), *answering, agreeing*

quad′-ru-ped (L. quatuor, pes), *a four-footed animal*

car-niv′-o-rous (L. caro, voro), *flesh-eating*

e-nor′-mous (L. e, norma), *beyond rule or measure, excessive*

I HAVE no doubt you think, as many other people do, that England and the world generally have always been pretty much like what they are now, and that the animals and plants which are found here and elsewhere are the same kinds of animals and plants which have always existed, and that there have never been any others in their places. Your own neighbourhood is about the same now, in these respects, as when you first knew it. Your father and grandfather, perhaps, cannot see any difference. There are the same hills and valleys, the same rivers and lakes, the same sea-side; the same animals, trees, and flowers, and everything else quite, as it seems, the same as of old; and you may think it was always thus, but if you do, you are very much mistaken.

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[1] For the meanings of the roots and prefixes in this and the following Spelling Lessons see the alphabetical list at the end of the volume.

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The world, with all things upon its land and in its waters, is continually changing. England is not the same in shape and size as it was a thousand years ago, and still less the same as it was 4,000 years ago. The rivers are continually deepening its valleys and filling up its lakes. The sea waves are constantly wearing away the coast in some parts and building it up anew in others. And what is taking place in England is being done everywhere else, a continual pulling down and building up.

Not only so. A great change has taken place, and is still taking place, in the plants and animals of the country. Many plants and animals are here now which were not here formerly, and many which found a home here years ago have long since disappeared, and are even now disappearing. The badger and the otter, which are now rarely seen, were much more common not very many years ago. Deer, which were at one time common enough in our forests, are now rare indeed, except in parks. The fox would probably have gone long ago did not gentlemen carefully preserve him for the purpose of hunting him. The wild boar, the wolf, and the beaver, of which you must have heard as having once lived wild in England, have become, as regards this country, extinct for a long time.

The same thing is taking place in America, South Africa, India, Australia, New Zealand. Wherever men go to cultivate the land, the plants and animals of the country disappear, and even *the men* too, and others take their place. The beaver and buffalo will, in time, be driven from North America, and the kangaroo from Australia. A gigantic pigeon, the *Dodo*, has become extinct in the Mauritius since the last 200 or 300 years; and a still more gigantic ostrich-like bird, the *Dinornis*, about ten or twelve feet high, lived in New Zealand at one time, but does not live there now. The remains only of these animals are found.

These things are greatly owing to man's interference; but far greater changes than these have been brought about here and in all other parts by other causes. It may appear strange to you when I say that the greater part, if not all the dry land of our country and of all other countries was built up slowly under the water; that the British Isles have been altogether, or in part, far below the sea again and again; and that where there is now sea there was probably dry land. You may be able, by-and-by, to see for yourselves, if you will only take the trouble, that this is really the case.

Now such changes in the position and relative level of land and sea cause a corresponding change in the climate of countries, and also do away altogether with one set of animals and plants, and introduce another and a different set. For instance, on examining the newest of the rocks of our own and of other countries, the gravels, sands, and clays on the river-sides, remains are found, such as the teeth, bones, horns, &c., of animals we should little think ever lived here, but which certainly did at one time live here in very great numbers.

About seventy years ago the carcase of a huge kind of elephant called a *Mammoth* (compared with which the present elephant is quite small) was found *frozen* in the gravel at the mouth of the Lena in the very north of Siberia! The flesh was on the bones, and the carcase covered with a skin which it took several men to carry, and which was covered with a close reddish wool, over which was coarse black hair more than a foot long. A rhinoceros so clothed was likewise found in the same neighbourhood. These animals lived in a very cold climate, and great numbers of their teeth; tusks of enormous length, and bones are found in Siberia, and used for ivory, though I scarcely need tell you that no such animals live there now.

These animals lived not only in Siberia, but also in this country; for the remains of monstrous elephants, rhinoceroses, great bears, tigers, hyænas, lions, wolves, reindeer, and many other animals, all different from any now living, have been, and are being found in the gravels, clays, cliffs, and caves in different parts of the British Isles; and with them are found *shells* such as live now only in the Arctic Seas. The remains of the ancient forests in which these large animals lived, and the stumps of the trees upon which many of them fed, are to be seen between high and low water on the Yorkshire, Norfolk, Devon, and other coasts, whence great quantities of their bones have been obtained. They have also been found in France, Germany, and America.

All these things show that England was then much colder than now—indeed, that it was in part covered with ice. This was a very long time ago, but *how* long it is impossible to say. All the present animals, in this country at least, have appeared since those mentioned above became extinct.

The rocks in the eastern counties, and about London, as well as those round Paris and some other parts, tell us that before this cold period, which lasted a very long time indeed, a set of enormous and strange beasts lived in this and other countries—animals in some respects like those of the cold period, though in others very different from them. With their remains are found those of palms and other plants and shells which are now found only *in warm or even hot parts* of the world. Even in Greenland and Spitzbergen similar plants have been found, showing that in this country and in others much farther north, the climate was then very warm from some cause or other which we do not know.

Among these remains are those of different kinds of elephants, rhinoceroses, hippopotami, camels, giraffes; of animals partly like a rhinoceros and partly like a horse; of a gigantic sloth, and an armadillo twenty times as big as the armadillo now living in South America; of a large kind of tapir; of an opossum, and kangaroo; as well as of monkeys, turtles, crocodiles, and many other kinds now living only in warm or hot countries, and generally very much larger than any to be found living now even there. Before this period there were, as far as is known, no great mammals, that is animals that suckle their young, in existence.

You will naturally ask whence these different sets of animals came to England. It is pretty certain that Great Britain and Ireland at different times formed part of the continent of Europe, when animals from the south and north-east could wander hither at their will. When changes in the land and water took place, the climate changing too, one set of animals and plants died out; and when another change occurred, and Britain became again joined to the continent, another, and a different set took their place, till at last the present animals appeared.

We must now go back to a time still more distant from our own—a time before any of these great elephants lived, even before there were any Alps, Andes, or Himalaya Mountains; before the chalk hills in the south of England, which are still older, were made. In that period there must have been a great river flowing through what are now the southern counties, perhaps from a large country now beneath the Atlantic, and whose great mouth stretched across from Buckinghamshire over into France, or even Germany. On the banks of that river roamed enormous lizards, compared with which the crocodiles of our day are very small indeed. Remains of such lizards have been found in Sussex, Kent, and other parts, and are now in the British Museum. Some of these fed upon plants, others were carnivorous. One of the largest, the *Iguanodon*, is thought to have been seventy feet long, and of great height. Besides these lizards were great bat-like animals. The remains of one which measured twenty-five feet across the wings have been found near Cambridge.

Let us go back into times still more ancient, and we shall find, in the rocks of the Severn valley, and other parts, enormous fish-like lizards of great length and size, which lived in the shallow seas which existed here at that time. One kind, called the *Ichthyosaurus*, or fish-like lizard, of which there were great numbers, swam about with large fin-like paddles, had an enormous mouth armed with long sharp teeth, and possessed eyes as large as small plates. Another kind threw out of the water a very long neck upon which was a small head with a beak like a bird's, but full of teeth.

These are only a few of the strange animals which have lived at different times in this and other countries. Their remains may be seen, in most cases changed into stone, in many museums, and you may, perhaps, find them in the rocks for yourselves. And should you live in or visit London, you may see what these creatures were like, for models of many of them stand on the borders of the lakes in the gardens of the Crystal Palace. H. T.

DISTRIBUTION OF ANIMALS.

dis-tri-bu'-tion (L. dis, tributum), *the act of dividing or spreading out*
zo-o-lo'-gi-cal (Gr. zoon, logos), *belonging to the part of natural history that treats of animals*
va-ri'-e-ty (L. varius), *change, difference*
ve-ge-ta'-tion (L. vigeo), *the growth of plants*
lux-u'-ri-ant, (L. luxus), *very abundant*
trop'-i-cal (Gr. tropè), *being within the tropics*
as'-cend-ing (L. ad, scando), *going up*
re-pre-sent'-ed (L. re, præ), *exhibited, described*
de-creas'-es (L. de, cresco), *becomes less*

There are very few boys who have not at some time or other visited the Zoological Gardens in London or one of the wild-beast shows which travel about the country. I am sure those of you who have been to such places must, on visiting them for the first time, have been very much surprised at the strangeness of the animals you saw there—animals very unlike those whose natural home is in England. There you find huge lions and tigers, bears, elephants, the rhinoceros, camel, giraffe, zebra, sloth, kangaroo, and various kinds of monkeys; birds of the brightest colours and most disagreeable voices; huge serpents, and, it may be, the crocodile; and others equally strange, whose homes, you are told, are in countries far off—in India, Africa, Asia, America, and Australia. So if you were to take ship and go to any of these far countries, as English people frequently do, your surprise at the animals you would by-and-by see would be even greater, for there they are in their natural condition. In Africa, for instance, you would find the lion, hippopotamus, and giraffe; in India the tiger; in America the sloth and armadillo; in Australia the kangaroo; in Greenland the huge white bear, and so on. You would also find the elephant, the lion, the rhinoceros, and the camel in Africa and Asia, though not quite the same kinds; and monkeys in these parts as well as in

America. But you would be unable to find the elephant, rhinoceros, lion, or camel in either America or Australia; neither would you see the kangaroo in Africa, Asia, or America. Such is the case with birds, reptiles, insects, fishes, shells, and other animals that live in the water; certain kinds are found in certain parts of the land or water, and each kind is confined more or less to its own proper neighbourhood or home.

We thus learn that animals are not scattered about the world anyhow, but that they have been distributed about by their Maker according to some order or plan which we should endeavour to find out. This is called the 'Distribution of Animals.'

In the first place, most, if not all, animals either themselves feed upon plants or upon those animals that do: those that feed upon plants being called herbivorous or plant-eating animals, such as the ox and sheep; and those which eat other animals being called carnivorous or flesh-eating, as the cat and dog. Now it is easy to see that the very existence of any sort depends upon that of plants, and we may fairly expect that wherever plants are most abundant, there will also be the greatest number and variety of animals; and such is found to be the case.

But the existence and abundance of plants depend upon the warmth or coldness, the dampness or dryness of the climate. The warmer and damper the climate of a country is, there will vegetation be the most luxuriant, there will be the most food, and there the greatest number of animals. Now you know, from what has been said in former lessons, that in the tropical regions of the earth it is very hot and damp, in the polar regions exceedingly cold, and that between these parts the climate is more or less temperate or mild. In the Arctic regions to the north of the Old World, there are but few plants of any sort, and those of the lowliest kind, such as lichens, mosses, and stunted trees. There also animals are few in number and in kind. As we proceed southwards, plants become larger, more numerous, and more various, animals increasing in like manner. But even in temperate regions most plants lose their leaves at the end of the summer, remaining bare till the next spring.

In the tropics vegetation is most abundant, the flowers most gorgeous, the plants are evergreen, and these regions swarm with animals of the strangest form, the largest size, and the gayest colours.

The like differences are observed in both animals and plants in ascending a mountain in the tropics. In the plains, plants and animals abound, higher up they differ in kind and become fewer in number, until at last both plants and animals disappear altogether.

In America, where the mountain chains run from north to south, the change of climate, and consequently of vegetable and animal life, is very gradual; but in the Old World, where the mountains run from east to west, the change is more sudden and marked. Animals depend not only upon climate but upon soil too. Some, like the monkeys, love the dense forest, upon the fruit of whose trees they feed; others, as the bison, delight in the broad grassy plain; some, like the hippopotamus, in the river, swamp, and thicket; and others, like the lion, deer, and wild ass, in the higher and drier plains.

The most northern part of Asia, as you see, is separated from North America by a very narrow channel of water called *Behring's* Straits: and it is very probable that at one time the two continents were joined together; so that pretty nearly the same kinds of animals are found in the north of North America, of Europe, and of Asia. In the extreme north are found the white bear, white fox, white hare, the walrus, the Greenland whale, and the seal. Farther south are the elk, reindeer, beaver, otter, brown bear, the bison, and the wolf. But the more southwards we go, the wider apart do the continents become, and the greater is the difference between the animals in the New World and the Old. Generally speaking, the quadrupeds of the Old World are much larger than those of the New. There is even a good deal of difference in kind between the animals of different parts of the Old World, especially of Asia and Africa.

In Asia and Africa are the lion, the tiger, leopard, panther, and hyæna; while in America these are represented by the much smaller puma, jaguar, and ocelot. The elephant of Asia is of a different kind from that of Africa, while the animal most like them in America, the tapir, differs from them both. The camel of the Old World is represented in America by the smaller llama and alpaca. Africa is the home of the clumsy hippopotamus, the long-necked giraffe, and the beautiful striped zebra; Asia, that of the wild horse and ass. Africa has its gorillas, apes, and baboons; Asia numerous monkeys of various kinds; while the monkeys of South America are smaller, and use their tails for hands.

The sloth, the ant-eater, the peccary or American pig, and the pretty little guinea pig, belong especially to America.

Not only are quadrupeds different in these countries, but the birds and reptiles also. The peacock is peculiar to India, the ostrich nearly so to Africa, and humming-birds to America; while parrots of various kinds belong to the Old and New World. The crocodile of the Ganges differs from that of the

Nile, and those of the American rivers from them both. Again, the huge serpent, the python, of Africa, answers to the equally huge boa constrictor of America.

The animals of Australia, namely, the kangaroo, the ornithorhynchus, or beast with a bill, are different, as I have said before, from those of America or Asia.

Not only do different kinds of beasts and birds live in different countries, but there is nearly or quite as much difference amongst the animals which live in the water. One kind of whale, the Greenland whale, is found in the Northern seas, the sperm whale in the Southern seas. Some fish live only in salt, and others only in fresh water; while some, like the salmon, frequent both. Some live mostly in rivers, others in lakes; some, such as the sturgeon, live in rivers in one part of the world; others, as the garpike of America, in rivers there. The herring, mackerel, pilchard and cod frequent our own shores; the tunny is found chiefly in the Mediterranean, and the terrible shark in the warmer seas.

Some shellfish, too, such as the mussel and pond snail, prefer fresh water; others, as the oyster, cockle, and whelk, live only in salt water. Those which live in the Arctic seas are very different from those which live in the British seas, and the shells of the tropical seas differ quite as much from both, and are far more beautiful in colour. The beautiful sea anemone abounds near our English coasts, but its cousin, the coral builder, will only live in tropical seas, where it builds up mountains of limestone in the form of coral reefs hundreds of miles long and as many feet thick.

Not only so. Just as certain land animals are found at different heights on the mountain side, so different kinds of sea animals live only at different depths in the water; some kinds delight only in the shallow water close to the shore, others live best in still deeper water, and others are found only in water deeper still. As life decreases and disappears as we *ascend* a mountain, so does it in *descending* into the sea, till, at a certain depth, no living thing has been hitherto found to exist. The coral polype will not live beyond a depth of 600 feet.

Man, and some of the animals which he has tamed, are found in most parts of the world; so that we find the horse, ass, pig, sheep, goat, and especially the dog, very widely distributed; but climate affects even these in time. H. T.

SOCIETIES OF ANIMALS.

sol'-i-tary (L. solus), *living alone, retired*
gre-gar'-i-ous (L. grex), *going in flocks or herds*
in-dis-crim'-i-nate-ly (L. in, dis, crimen), *without distinction*
com-mu'-ni-ty (L. communis), *the whole body, the commonwealth*
dis-clos'-ed (L. dis, clausum), *revealed, uncovered*
tran-quil'-li-ty (L. tranquillus), *quietness, a calm condition*
sta'-men (L.), *the thread called the filament, and the tip called the anther, form the stamen of a flower*
lar'-væ (L.) *insects in the caterpillar state*
as-si-du'-i-ty (L. ad, sedeo), *diligence, closeness of application*
un-gov'-ern-a-ble (L. in, guberno), *that cannot be controlled*
an-ten'-næ (L.), *the feelers of an insect*
an-tag'-o-nist (Gr. anti, agon), *an opponent*
re-cip'-ro-cal (L. reciprocus), *acting in return, done by each to the other*
ir'-ri-ta-ted (L. irrito), *made angry*
pro-bos'-cis (Gr. pro, bosko), *the trunk or snout of an animal, the trunk-like tongue of a bee or butterfly*
pet'-al (Gr. petalon), *a flower-leaf*
Or'-i-fice (L. os, facio), *opening*
ex-traor'-di-na-ry (L. extra, ordo), *remarkable, beyond ordinary*

Some animals live alone, or in pairs; when this is the case they are said to be solitary in their habits. The bear, the lion, and the vulture are examples of this kind. Some animals associate together in large numbers, as oxen, the deer tribe, rats, and some kinds of monkeys; when this is the case they are said to be gregarious. These animals, though they herd together, and seem to love the company of each other, yet do not unite with a view to any common operation, such as constructing common habitations, or mutually and indiscriminately nourishing and protecting the offspring produced by the whole society. Yet in many instances these animals mutually assist and defend each other from the attacks of a common enemy.

Thus when a herd of wild oxen is pasturing in a meadow, if a wolf makes his appearance the herd instantly forms itself in battle array, and present its united horns to the enemy. A family of wild hogs never separate until the young have acquired strength sufficient to repel the wolf. When a wolf threatens an attack, the whole family unite their force and bravely defend each other.

Some animals, however, not only live together in numbers, but carry on certain operations which have a direct tendency to promote the welfare and happiness of the whole community. The beavers, the bees, and the ants are the most noted of these. As an illustration of this kind of animals we purpose in this lesson to describe—

A SOCIETY OF BEES.

The society of a hive of bees consists of one female or queen; several hundreds of males or drones; and many thousands of workers. As each of these have been described in previous lessons, and also the way in which the workers make the wax and construct the comb, it need not be repeated here. This lesson will rather refer to the life that is lived in the hive. First, then, a few words about the queen-mother, who is both the parent and the ruler of the community: only one of these royal bees is found in the same colony when it is in its ordinary state. Now as there are sometimes as many as sixteen royal cells in a hive, in which young queens are hatched, the nurses who tend them release only one at a time, just when she is wanted to take the place of a queen who has died, or to lead off a swarm for the purpose of forming a new colony. Should it happen, as it sometimes does, that two queens are disclosed at the same time a curious scene takes place. It is thus described by Huber, the great naturalist:—'Two young queens left their cells one day almost at the same moment. As soon as they came within sight, they darted upon each other as if inflamed by the most ungovernable anger, and placed themselves in such an attitude that the antennæ of each were held by the jaws of its antagonist; head was opposed to head, trunk to trunk, abdomen to abdomen; and they had only to bend the extremity of the latter and they would have fallen reciprocal victims to each other's sting. As soon as they were thus circumstanced a panic fear seemed to strike them, and they disengaged themselves and each fled away. After a few minutes were expired, the attack was renewed in a similar manner, with the same issue; till at last one suddenly seizing the other by her wing, mounted upon her and inflicted a mortal wound.'

As the summer advances the number of bees increases to such an extent that there is not room enough for them in the hive. To prevent the inconvenience which would result from this state of affairs, the old queen, after having some time previously laid several eggs in the royal cells, leads off a swarm and forms a new colony. Upon this the workers allow a new queen to come forth and occupy the vacant throne, or to lead off other swarms.

When the queen comes forth, should she approach the other royal cells the workers on guard seem greatly irritated against her, and pull, and bite, and chase her away; and she enjoys tranquillity only while she keeps at a distance from them. Sometimes she makes a peculiar sound, which so much affects the bees that they hang down their heads and remain motionless. When the noise ceases they resume their opposition. After a short time the young queen becomes much agitated, and communicating her agitation to others, the confusion increases till a swarm leaves the hive, which she either precedes or follows. The other young queens are treated in the same manner while there are swarms to go forth, but when the hive is sufficiently thinned, they are allowed to come forth unheeded, and fight, until one alone remains to fill the throne of the parent-hive.

If by any chance the queen dies, or leaves the hive after the swarming time, the bees manifest great agitation, leave their usual work, run over the comb in all directions, and as they pass each other cross their antennæ, and strike them lightly. Disorder and confusion increase rapidly, till the whole population is in a tumult. The bees leave the hive, spread themselves all around; re-enter and go out again and again. After the space of two or three hours the workers resume their care of the young, and take steps to repair the loss, by converting one of the ordinary cells into a royal cell, and treating the grub in it after the manner of a royal grub.

If a strange queen is introduced into the hive within the first twelve hours after the old one is lost she is kept a close prisoner until she perishes. If, however, twenty-four hours have elapsed before the new queen is introduced she is not killed, but the workers that are near her first touch her with their antennæ, and then pass their proboscis over all parts of her body. Then others come forward and do the same; all then beat their wings at the same time, and range themselves in a circle round their new sovereign. When the queen begins to move, the circle opens to let her pass, and all follow her steps. She soon receives the same tokens of regard in other parts of the hive, and, being acknowledged queen by all, begins to lay her eggs.

The greatest attention and regard are paid to the queen by all the workers; they are constantly on the watch to make themselves useful to her; they offer her honey, they lick her with their proboscces, and wherever she goes she has a Court to attend upon her.

The drones are the male bees. These do not store up honey, nor take any part in the labour of the hive, and so they are generally killed by the workers during the months of July and August. Now as the eggs which produce the drones are not laid until April or May their life is indeed short.

The workers are the most numerous members of the community, and the busiest also; they care for and nurture the young; they build the comb; they attend and render state to the queen; they gather the food for the young brood, and store up provision for the winter; the former being found in the pollen of flowers, and the latter in the nectar.

When a bee visits a flower it darts its tongue between the stamens and petals, and abstracts all the nectar, which passes into the honey-bag, when it is transformed into pure honey; and when it returns to the hive this treasure is placed in one of the cells provided for this purpose. When the stomach of the bee is filled with honey, it next, by means of the hairs with which its body is covered, collects the pollen from the anthers of the flowers, gathers it together, and places it in the basket, as it is called. When the bee arrives home this pollen is brushed off the creature's legs into one of the cells of the honey-comb, and made into bee bread for the use of the young larvæ.

Another substance collected by the workers is called propolis, a kind of gummy resin obtained from various trees. This, like the pollen, is carried home in the 'baskets,' and is used by the bees in finishing the combs, in stopping up every orifice by which cold, wet, or any enemy can enter, in covering the sticks which support the combs, and in spreading it over a considerable portion of the interior of the hive.

Bees when laden and returning to the hive always fly in a direct line, thus saving both time and labour. And we are compelled to admire the instinct which enables them to make for their own particular abode without deviation.

One of the employments of the workers when at home is the ventilation of the hive; and this they accomplish by fanning with their wings, the vibrations of which are so rapid as to render them almost invisible. When they are engaged in this process, they fix themselves as firmly as possible to the place they stand upon by means of their feet and claws. During the summer a certain number of workers may always be observed vibrating their wings before the entrance of the hive, and a still greater number are engaged within it in the same employment. This ventilation of the hive is carried on both in summer and in winter, and seems, therefore, to be done not only to keep the hive cool, but also for the purpose of keeping the air in the hive pure.

Bees are extremely neat in their persons and habitations, and remove every nuisance with great assiduity; when they cannot remove it, they cover the substance with propolis, so as to prevent any offensive odours from incommoding them. Should a slug or a snail enter the hive, which they sometimes do, the bees will cover the creatures with propolis, and thus make them prisoners.

Those persons who have most carefully watched bees think that they have the means of making each other understand their wishes, their fears, or their joys, and this is mainly accomplished by the use of the antennæ.

It is also thought that they can remember agreeable sensations, and even manifest various feelings, as anger, pleasure, &c. Many more curious things might be told about these wonderful little creatures, but sufficient has been said to show the extraordinary nature of their habits and instincts, and to lead us to admire the wisdom and goodness of God, the maker and keeper of the bee.

LINES TO THE BEE. BY PROFESSOR SMYTH.

'Thou cheerful bee! come, freely come,
And travel round my woodbine bower;
Delight me with thy wondering hum,
And rouse me from my musing hour.
Oh! try no more those tedious fields.
Come, taste the sweets my garden yields;
The treasures of each blooming mine,
The bud, the blossom,—all are thine.

'And, careless of this noontide heat,
I'll follow as thy ramble guides;
To watch thee pause and chafe thy feet,
And sweep them o'er thy downy sides:

Then in a flower's bell nestling lie,
And all thy envied ardour ply.
Then o'er the stem, though fair it grow,
With touch reflecting, glance, and go.

'O Nature kind! O labourer wise!
That roam'st along the summer's ray,
Glean'st every bliss thy life supplies,
And meet'st prepared thy wintry day!
Go, envied, go—with crowded gates
The hive thy rich return awaits;
Bear home thy store in triumph gay,
And shame each idler of the day.'

J. H.

INSTINCT OF ANIMALS IN PROVIDING FOR THEIR YOUNG.

ex-pand'-ed (L. ex, pando),	*spread, laid open*
fab-ri-ca'-tion (L. faber),	*the act of building*
in-var'-i-ably (L. in, varius),	*unchangeably, constantly*
de-pos'-it (L. de, positum),	*to lay down, to lodge in trust*
at'-mo-sphere (Gr. atmos, sphaira),	*the air which surrounds the earth*
pro'-gen-y (L. pro, gigno),	*offspring*
u-ni-form'-ly (L. unus, forma),	*without variation*
trans-for-ma'-tion (L. trans, forma),	*change of form*
suc-ces'-sion (L. sub, cedo),	*a following of persons or things in order*

If you were to shake some caterpillars off a tree in every direction, all of them would instantly turn towards the trunk and climb up, though they had never formerly been on the surface of the ground. As soon as a bee leaves its pupa state, and its body is dry, and its wings expanded, without any instruction it betakes itself to the collecting of honey, or the fabrication of a cell. These and all such actions of animals are the result of instinct. That is, they are done independently of instruction, observation, or experience.

It is this natural instinct that leads animals to provide for their own wants, and those of their offspring. Some of the actions which animals perform in carrying out this purpose are very wonderful. Insects invariably deposit their eggs in situations most favourable for hatching, and affording nourishment to their future progeny.

Butterflies and moths feed upon the nectar of flowers; their offspring, however, which are caterpillars during one stage of their existence, feed upon plants. Now the parent insects uniformly fix their eggs upon such plants as are most agreeable to the palate of their young, as in the case of the cabbage butterfly.

The wood-piercing bee—one of the solitary species—gnaws a large hole in some old piece of timber, in which she lays her eggs. The larvæ, when hatched, however, do not feed upon wood. How, then, are they to be nourished? Here the instinct of the mother bee leads her to make the necessary provision. After laying the eggs in the cells, she deposits a quantity of glutinous matter; and always sufficient to nourish the pupæ produced from the eggs, till the time of their transformation into bees. After the parent bee has deposited the food, she pastes up the mouth of the hole, and leaves her future offspring to the provision she has made for them.

The solitary wasp digs holes in the sand, in which to deposit her eggs, always placing one egg in each hole. But the larvæ when hatched cannot eat sand. How, then, are they to be nourished? The instinct of the parent provides for the wants of the young: and this too, in a most wonderful manner. The wasp is not a flesh-eater, but its larva is, and so it collects a number of small green caterpillars, rolls them up in a circular form, piles them up one above another, and fixes them in the hole in such a manner that they cannot move. When the larva is hatched it is plentifully supplied with food. The green caterpillars are devoured in succession, and the number deposited is always sufficient to supply food to the creature until it is changed into a wasp, when it issues from its hole, and procures its own nourishment.

Equally wonderful is the instinct of the scavenger beetle, which, while providing food for its young, becomes one of the most useful of all insects. These creatures abound in many parts of Africa, and serve the most important purpose of keeping the villages clean. When any animal filth is dropped, its scent attracts these beetles, and they immediately commence rolling it away in round pieces about the size of a small cricket ball. When the beetles find a place fitted by its softness for the deposit of their eggs and the safety of their young, they dig the earth out beneath the ball, till it sinks beneath the surface and is covered. They then deposit their eggs within the mass of offensive matter. By-and-by the eggs are hatched, and each larva begins to devour the inside of the ball. After a time the larvæ undergo their change, and a beetle comes above the ground, to do in its turn what the parent did. In this case the instinct of the parent serves two purposes—one, the providing proper food for its young; the other, helping to keep the atmosphere pure.

Not less remarkable is the way in which birds provide for their young; especially those birds which belong to the perching order. Thus the weaver bird constructs its beautiful nest on the slender leaves of ferns and other delicate plants, which overhang some stream. The eggs which are laid in them are out of the reach of the monkeys and the snakes: the former would devour the eggs, the latter both the eggs and the young birds.

The tits go in search of grubs and worms for their young, and in doing so make a vast number of journeys. One pair of these interesting little creatures was watched while they were rearing their brood. The period of observation extended over eighteen hours. In that time they passed 475 times from the nest to the ground, a distance of 150 yards. Each time they brought two or three caterpillars to the young birds. The whole distance travelled was 237,500 yards: a distance equal to 134 miles; and the number of caterpillars destroyed would, at an average of two and a half each journey, amount to 1,185. Hence the value of small birds in keeping in check the insects, and the folly of destroying such useful friends of the farmer and gardener.

Many more instances of the wonderful instinct of animals might be given, but these will be sufficient to lead the reader to wish to know more about the subject.

J. H.

THE MEANS OF PROCURING FOOD IN ANIMALS. (*First Lesson.*)

ma-tu′-ri-ty (L. maturus), *ripeness, completion*
ro′-dent (L. rodo), *a gnawing animal*
ru′-mi-nant (L. rumen), *an animal that chews the cud*
de-vel′-op-ment (Fr. développer), *an unfolding, a disclosure*
in-ver′-te-brate (L. in, vertebra), *without a back-bone*
vi′-brate (L. vibro), *to move backwards and forwards, to quiver*
tu′-bu-lar (L. tubulus), *resembling a tube or pipe*
ap-pa-ra′-tus (L.), *instruments necessary for doing a thing*
lo-co-mo′-tion (L. locus, motum), *the power of changing place*
a-quat′-ic (L. aqua), *belonging to water*
pro-ject′-ile (L. pro, jactum), *impelling forward*

All animals require food to enable them to grow and strengthen their parts when young, and to preserve health and vigour after they have arrived at maturity.

Some animals, as the elephant, the horse, all the rodents and the ruminants, feed entirely on vegetable substances. These are said to be herbivorous. Others, as the lion, the tiger, the dog, &c., feed almost entirely on flesh. These are said to be carnivorous. Others again, as the bat, the hedgehog, and the mole, feed on insects, worms, &c. These are called insectivorous. Some will eat any kind of food. These are said to be omnivorous.

Whatever may be the food of animals, we find that the formation of the mouth and the development of the senses are adapted to the discovery and the obtaining of the right kind. Some of the contrivances are very curious, and not a few are wonderful. We will notice a few, choosing an example from each of the great divisions of the animal world.

First, insects, and other invertebrate animals.

The food of butterflies, moths, and bees is the nectar of flowers, a sweet liquid found in the centre of the newly opened blossoms, and contained in what is called the nectary. But how are the creatures to obtain this liquid? The bee, it is true, is small enough to crawl into some of the flowers; but not so with many of the butterflies and moths. And even if they were able to crawl in they would not be able to obtain their food with a mouth fashioned like that of most animals. Such being the case, there is a special provision made, all these creatures being furnished with a long trunk-like tongue called a proboscis, which, in the moths and butterflies, is spiral and tubular, and when not in use is rolled up round itself, like a watch spring. When uncoiled the proboscis is long enough to reach to the bottom of the flowers, and it is through this tube that the insect obtains its liquid food.

The spider feeds upon flies. But these are mostly on the wing; and the spider cannot fly. What, then, is to be done? They must be snared while pursuing their giddy flight. But how can this be accomplished. Let us see. A spider is furnished with a bag, which is placed at the end of the abdomen and in connection with it is a spinning apparatus consisting of four spinnarets. From these the creature can draw out silken threads, which, being sticky, serve, when made into a web, to secure the flies as they touch it in their flight and are entangled in its meshes.

Now let an example be taken from the Mollusca.

The Oyster.—This creature is not furnished with any organs of locomotion, and hence never moves from the place where it may chance to be. And yet it must eat or it will die. Its food consists of very minute animals which are found in the sea. Now, since the oyster cannot go in search of these, they must be brought to it. And this is accomplished in a curious way. The oyster, like all aquatic animals, breathes air through the medium of water. In order, then, for the breathing apparatus to be supplied with water, the outer edge or beard of the oyster, as it is called, is covered with minute hairs, termed cilia. These are moved backwards and forwards, and their motion causes the water around them to move. When, then, the animal vibrates the cilia, a current is set up: the water passes into the shell, over the body of the oyster and out again, and this takes place during the whole time that the cilia vibrate. Whatever is in the water passes into the shell, and the animal is thus able to secure its food.

Among the reptiles the chameleon is perhaps the most wonderful instance of the special provision made to enable the creature to obtain its food. This interesting little lizard feeds upon flies and other insects. But it can neither run after them, nor snare them like the spider. It is therefore furnished with a curious projectile tongue, which it can thrust out and draw in with amazing rapidity. This tongue, which is several times the length of the head, is hollow, and when not in use is drawn into itself, something after the fashion of a telescope. At the end of the tongue there is a little knob, which is kept moist by a sticky fluid which serves to hold the fly or other insect secure when it touches it. So rapidly can this tongue be thrust out and drawn back that it is difficult to see it when it is in use.

The frog is another insectivorous reptile, feeding upon slugs, beetles, flies, and such-like creatures. These are seized by means of the tongue, the arrangement of which is very curious, altogether different from that of the chameleon. In the case of the frog, the tongue is not disproportionately long for the size of the animal, and yet it can be darted out far beyond the lips. And this is provided for by the position of the tongue being reversed. The root of the tongue is fastened to the inner part of the bottom lip, and the tip is therefore directed towards the throat. This is always its position when at rest, and the animal is thus enabled to thrust it out some distance beyond its mouth. In seizing its prey it is launched forth like lightning, and as quickly retracted, with the captive fly or beetle adhering to its extremity.

J. H.

MEANS OF PROCURING FOOD IN ANIMALS.

(*Second Lesson.*)

pro-vi′-sion (L. pro, visum), *the act of providing, previous stipulation*
noc-tur′-nal (L. nox), *relating to the night, nightly*
ex′ter-nal (L. exter), *outward, visible*
ex-trem′-i-ty (L. extremus), *the utmost point or part*
ap-pend′-age (L. ad, pendeo), *something added*
man′-di-ble (L. mando), *the jaw*
sen′-si-tive (L. sensum), *having acute feelings*
a-dap-ta′-tion (L. ad, apto), *fitness*
cy-lind′-ri-cal (Gr. kulindros), *having the form of a cylinder*
strat′-a-gem (Gr. stratos, ago), *a trick*

Among birds there are many examples of special provision being made to enable them to procure their food easily. A few only can be noticed. The owl feeds upon mice, young rats, and other timid nocturnal animals. To obtain these, several things are necessary, namely, keen sight, acute hearing, and noiseless flight. All these are amply provided for. The eyes are large, and placed more in front of the head than is usually the case in birds. Around each eye is a disk of feathers, which may, it is thought, serve to gather up the rays of light, and throw them into the large extended pupils.

The feathers which form the disk are set on one of the edges of the external ears, which are also very large. It may be, then, that the very act of watching for its prey may open these external ears, and so enable the bird to detect its presence. Whether this be so or not, it is quite certain that the owl can hear the least noise, even the movement of a mouse among the straw in the barn-yard.

But this quick sight and quick hearing would be of little use, unless the prey could be reached noiselessly. This is fully provided for. The plumage is loose and downy, and consequently offers but little resistance to the air. Having reached its prey, it seizes it with its sharp curved talons, and carries it away to eat.

The common snipe feeds upon worms and insects, which are obtained by the bird probing the mud with its lengthened bill. But how is the bird to know where the worms are? And then, having discovered them, by what means are they to be obtained? In a very peculiar way. Thus: the bill is thickened at its extremity; the thickened part is soft and tender, and covered all over with nerves. There are three sets of these, and they pass, first along the roof of the mouth, and then along the upper mandible to the point of the bill, rendering it a sensitive organ of touch.

But this is not sufficient to secure the desired end, for if the bird had to withdraw its bill in order to seize the worm, the chances are that before it could do so, the prey would have moved to another place. A second special contrivance is added. Connected with the bill is a set of muscles, which, by closing the upper part of the mandibles, cause the point to open, and thus at the very time that the bird is made aware of the presence of its prey, means are at its disposal for securing it.

In the class Mammalia, there are many examples of the wonderful adaptation of structure to the mode of obtaining food. One or two only can be noticed.

The elephant feeds upon vegetable substances; but its food is not within reach of its mouth. It can neither climb the trees to obtain the leaves, nor lower its head to bite the grass. The animal is, therefore, provided with a large cylindrical trunk or proboscis. This organ, which is really a prolongation of the nose, is composed of several thousands of muscles, and is so flexible that it can be bent to any curve, can be shortened or extended. At the extremity there is an appendage like a finger, and by the aid of this the animal can pick up the smallest object. At the same time, the trunk possesses great strength; with it the elephant can not only pick up the tender blade of grass, but can also break off the large branches of a tree, or, if needs be, pluck one up by its roots.

In some animals the senses enable them to discover their food. The dog tribe scent their prey at a considerable distance. On account of this, man trains some of these animals to hunt for game. The cat by the same sense discovers the retreat of the mouse..

The Ruminants have the most acute sense of smell. Cows on board ship have been known to sniff the air when yet many miles from land, recognising by their acute sense of smell the odours of the distant clover fields. And the camel, when travelling in the desert, has been known to detect the presence of water while at a considerable distance from the desired spot.

Some animals obtain their food by stratagem. One very remarkable instance of this is seen in the case of the ant-lion, an insect somewhat resembling a wood-louse, but larger. The favourite food of this creature is the ant. But the ant-lion always walks backward, and therefore cannot pursue its prey. As it cannot obtain its food by open attack, it lays a snare for it; and this it does in the following way. It digs a funnel-shaped hole, the sides of which are very steep. At the bottom of this trap it lies concealed. When an ant happens to go near the margin of the funnel, the fine sand in which it is dug gives way, and the unwary ant falling to the bottom, is immediately seized by the ant-lion, buried under the sand and consumed.

The trap is now repaired, and the crafty creature lies in ambush for fresh prey.

J. H.

THE MEANS OF DEFENCE IN ANIMALS.

e-lude′ (L. e, ludo), *to escape by stratagem*
un-per-ceiv′-ed (L. in, per, capio), *not seen*
re-sem′-ble (L. re, similis), *to be like*
con-ceiv′-ed (L. con, capio), *thought, imagined*
fo′-li-age (L. folium), *leaves, a cluster of leaves*
e-ject′-ed (L. e, jactum), *cast forth or out*
dis-tin′-guish (L. di, stinguo), *to note the difference*
di-ver′-si-fied (L. di, verto), *made different, varied*
con-ceal′-ment (L. con, celo), *hiding, a hiding-place*
sim′-u-la-ting (L. similis), *pretending, counterfeiting*
in-ev′-it-a-ble (L. in, e, vito), *unavoidable*

Animals have many foes, and are in constant danger of being injured or destroyed. Such being the case, God has provided them with ample means of defence. The various provisions made for this purpose are of two kinds—first, those which are secured by the form and colour of the animal, and which may be called the passive means of defence; and second, those which are provided for by some special organ, or the use of the ordinary organs. These may be called the active means of defence.

Among the former may be noticed instances in which the *colour* of the animal is its chief defence. The ermine, a species of polecat, is very much prized on account of the richness and beauty of its fur. This animal inhabits the northern parts of both the Old and New continents, in countries where in the winter the ground is always covered with snow. As it is the winter coat of this animal that is so much prized, it is then, of course, that the hunter seeks it; but the little creature often eludes his search. And how? By a change of colour. In the spring and summer the fur of the ermine is of a beautiful brown above, and yellowish-white beneath; as the winter approaches, the brown changes into white, and thus the animal is not readily perceived as it runs about in the snow. In the spring the colour again changes into brown, and so once more affords protection to the animal.

There are many other instances of the colour of the animal according with the colour of its surroundings. The plumage of the partridge is of an earthy brown colour, and thus it can hide itself among the clods of the field, feeding and taking care of its brood unperceived.

The fur of the squirrel is brownish red, corresponding in a great measure to the colour of the bark of the trees on which it lives.

Among the insect tribes there are many wonderful examples of the protection afforded to these little creatures by their colour.

Caterpillars mostly resemble in their colour the substances on which they feed. Thus the caterpillars of the cabbage butterfly are green, while those of the privet moth are so exactly the colour of the under-sides of the leaves of that tree, upon which it usually rests in the day-time, that a leaf with one on may be held in the hand, and yet the animal not be seen. Again, the colour of many of the butterflies resembles the hues of the flowers on which they alight to obtain their food.

Then, again, the *form* of some insects is a means of their defence. There is a wonderful example of this in a curious creature called the devil's horse. This insect is a native of Brazil, and so much resembles a sprig of a tree that unless it is seen to move it can scarcely be conceived to be anything else than a dried twig.

The leaf-insect, or the mantis, as it is called, is another example. So closely does the form of these creatures resemble the foliage of the trees on which they live, that it is almost impossible to distinguish them when they are at rest.

The active means of defence in animals are not less striking than the passive; indeed they are more numerous and diversified.

Some animals assume an attitude which becomes their defence. Thus the woodlouse, when alarmed, rolls itself up in the form of a ball. In this attitude, its legs, and the under-side of the body, which are soft, are entirely covered and defended by the hard scales which cover the upper surface of the animal.

The hedgehog cannot escape from its foes by flight, nor by concealment, but as it is covered with a coat of mail in the shape of sharp spines, when danger threatens it rolls itself up in a ball. The act of bending the body round causes the spines to project, and these prove a sure defence against dogs or other enemies.

Some animals endeavour to protect themselves from danger by simulating death. This is the case with certain insects and spiders. When the spider is touched it folds up its legs, falls from its place, and remains motionless for some time. Several kinds of beetles use the same means to elude their enemies.

In some cases animals repel their assailants by emitting fetid vapours, or by discharging a fluid from organs especially prepared for the purpose. Such is the case with the North American skunk. Among the insect tribes the most celebrated is the bombardier beetle. When this beetle is beset by its foes, and when destruction seems inevitable, then a loud explosion may be heard, and a blue smoke, attended by a very disagreeable scent, may be seen to proceed from the end of the abdomen, which immediately stops its assailant. This discharge can be made twenty times in succession if necessary.

The cuttle-fish, which, by-the-by, is not a fish, but a mollusk, eludes its enemies by ejecting in large quantities a black, inky fluid. This substance, which is contained in a bag in the body, can be spouted out in great abundance whenever the animal pleases, and when it is ejected it makes the water quite black for a considerable distance around. Under the concealment thus obtained the cuttle darts away from its foes; and as the animal always swims backwards, its safety is completely secured.

In many cases the means of defence in animals is found in the use of their limbs, or of some special weapon. Of this kind is the sting of the bee, the wasp, the hornet, and the scorpion; the horns of cattle, and the trunk and tusks of the elephant. When the small Norwegian horses are attacked by bears, instead of striking with their hind legs they rear, and by repeated strokes of the forefeet either kill their enemies, or compel them to retire.

Some animals depend upon their power of flight for safety. The deer and the hare are common examples of this. When these animals are set upon by dogs they run with great speed, and after running for some distance, suddenly return upon their former track—or double, as it is called—and so are often enabled to save their lives.

Whatever may be the particular means of defence an animal has, it is always the very best it could have, and shows the goodness of the Creator in so carefully providing for the protection of His creatures.

J. H.

THE MIGRATION AND HIBERNATION OF ANIMALS.

mi-gra′-tion (L. migro), *removal*
hi′-ber-na-tion (L. hiberno), *act of sleeping through the winter*
her-biv′-or-ous (L. herba, voro), *herb-eating*
pe-ri-od′-i-cal-ly (Gr. peri, hodos), *at stated periods*
nu-tri′-tious (L. nutrio), *having the quality of nourishing*
res′-i-dence (L. re, sedeo), *place of abode*
quad′-ru-peds (L. quatuor, pes), *four-footed animals*
har′-ass-ed (Fr. harasser), *fatigued, annoyed, perplexed*
in-sur-mount′-a-ble (L. in, super, mons), *that cannot be overcome*
tor-pid′-i-ty (L. torpeo), *sluggishness, inactivity*

It has been shown in a previous lesson that all animals must have food, and that the substances upon which they feed are various, being obtained from both the animal and vegetable world. In some countries the proper food of certain animals cannot be procured throughout the whole year. For instance, in the temperate and frigid climes, those animals which prey upon insects cannot obtain them in the winter: bats and swallows are examples of these. Then some animals feed on worms and such-like creatures, which are found in the mud and ooze in the neighbourhood of rivers. The frost of winter hardens the ground, and then they cannot be obtained. The same is true in the case of some of the herbivorous animals.

Such being the case, in order that the animals may not perish through hunger, one of three things must take place, the animals must either store up food for winter use, or they must pass to those places where the food is to be found, or they must pass the winter in a state of sleep, so as to be able to do without food. In the case of vegetable-feeders, the first of these takes place, as in the case of the squirrels. The second and third often occur. The former of these is called the migration of animals, and the latter the hibernation. A few facts respecting these will be interesting.

We will speak first of the migration of animals.

Swallows are insect-feeders, preying upon gnats, flies, and moths, which they catch while on the wing. In England these insects are found in greatest abundance between the months of May and September; and it is during these months that swallows abound. In Britain four species of swallows appear in summer and disappear in winter. These are:—

1. The common house swallow, which arrives about the middle of April, and remains until the end of September.
2. The martin, which arrives soon after the swallow, and departs about the beginning of October.
3. The sand martin, so called because it makes its nest in holes dug in the sides of sand-pits. This bird makes its appearance soon after the house swallow, and leaves again about the last week in September.
4. The swift, which seldom visits us until the beginning of May, and generally leaves us about the middle of August.

The winter home of the swallows which visit England in the summer, is the most southerly parts of Europe and the northern parts of Africa. The migration of swallows is not confined to these countries, but extends to Norway, North America, and many other parts of the world.

Swallows, however, are not the only birds that migrate. The cuckoo regularly visits this country about the middle of April, and leaves again before the autumn sets in; since it is between these two periods that its favourite food, which consists of caterpillars and moths, is found. The nightingale is another bird that visits us in the summer.

Among the birds that visit this country in the winter may be mentioned the wild swan, whose summer residence is the lakes, marshes, and forests of Norway and Lapland, from which places they migrate on the approach of winter to more southerly shores.

The wild goose, the solan goose, the stork, and the heron, are all birds of passage.

But migration is not confined to the feathered tribes. Quadrupeds likewise perform partial migrations for the purpose of obtaining their food. Thus among the stags, the reindeer leaves the mountains and comes down to the plains and copses, that it may find food and shelter. When the summer commences, these animals are harassed by flies and other winged insects, and to avoid these enemies they once more seek the mountains.

In Norway and Lapland there is a species of rat which periodically makes migrations, and in such numbers that the inhabitants of those countries imagine that they fall from heaven. According to Linnæus, the great naturalist, who paid particular attention to these migrating rats, it appears that, when about to commence their journey, they assemble in immense numbers. In their march they pursue a straight line, unless they are forced to turn aside by some insurmountable obstacle; when this is passed they resume their former course.

Then, again, some particular kinds of fish make very long journeys for the purpose of depositing their spawn. The salmon, the herring, the pilchard, and the mackerel, are the most common examples of these.

The salmon lives in both salt and fresh water. It leaves the sea in the spring and ascends the rivers in large shoals. When it has deposited its spawn in the ground at the bottom of the river it suffers itself to be carried by the current to the sea again.

The herring arrives off our coast in May and June, not, however, all round our islands; but keeping to the more northerly parts. The pilchard appears in vast shoals off the coast of Cornwall in the months of July and August.

This annual migration of fish is a great benefit to man, supplying him with a vast store of cheap and nutritious food, and giving employment to a large number of people.

Our next subject of consideration is the hibernation of animals.

Hibernation takes the place of migration in the case of those animals that from their structure are not fitted to undertake long journeys to obtain their food.

The bat is an example of this. On the approach of winter, when the insect tribes are either dead or themselves hibernating, the bat retires to its place of abode, some crevice in an old tower it may be, and, hanging itself up by its hind feet, gathers its wings round its body and goes into a state of torpidity. The sun of spring revives the creature, and it comes out of its retreat. The rays of the sun which brought out the bat brought out also the insects upon which it feeds.

The polar bear is another example of this. When the winter cold is freezing the whole surface of the sea, the bear seeks some hole in a rock or ice cliff, coils himself up, allows the snow to cover up both the den and himself, and sleeps in security, while the fat which has accumulated under his skin in the summer keeps his blood warm, and supplies him with nourishment; the snow, from its being a non-conductor of heat, also assisting to preserve the animal alive. Surely in this, as in the other instances described, we see the wonderful wisdom and goodness of the Great Creator, and His care for the happiness of all His creatures; and may well say with the Psalmist, 'All thy works praise thee, O Lord.'

J. H.

CLOTHING, ITS SOURCES AND MANUFACTURES.

in-ge-nu'-i-ty (L. ingenium), *invention*
lo-cal'-i-ties (L. locus), *places*
an-ti'-qui-ty (L. antiquus), *old times*
ref-u-gee' (L. re, fugio), *one who flees for refuge*
rev-o-ca'-tion (L. re, voco), *the act of recalling*
sus-pend'-ed (L. sub, pendeo), *hung, made to depend upon*
in-ter-lace'-ment (L. inter laqueo), *one within the other*
rep-re-sen-ta'-tion (L. re, præsens), *the act of exhibiting, image*
par'-al-lel (Gr. para, allelon), *extending in the same direction and keeping always the same distance apart*
al-ter'-nate-ly (L. alter), *by turns*
per-pen-dic'-u-lar-ly (L. per, pendeo), *upright, at right angles*

MAN is the only animal that has to provide a covering for the body. This is an advantage rather than otherwise. First, because it enables him to select the best kind of material for the purpose, to use his ingenuity in converting the raw material into the finished garment, and his taste in arranging and fastening the various articles of dress. Second, because it enables him to adapt his covering to the various climates of one country, and the different climates of the various localities in which he may be placed.

Animals are for the most part within certain limits of a country, and their covering adapts itself to the changes of seasons; the fur, hair, or feathers thickening on the approach of winter, and thinning again as the summer advances. But the summer dress of the animals found in the northern parts of Europe would be quite unfit for the climate of the tropics. Now as civilised man does not of necessity confine himself to any one locality, it is an immense advantage to him to be left to provide his own covering.

The sources of man's clothing are found in both the animal and vegetable world. At the present time the materials used are, wool, silk, and fur—three animal substances; and cotton, flax,and hemp—three vegetable substances. The two former, however, are the most commonly used. But these substances were not always used in this country. The Ancient Britons clothed themselves in the skins of the animals which they caught in the chase. Woollen garments were not much worn until after the Norman conquest. The wool was spun by the unmarried daughters of the nobles, and hence the origin of the word *spinster*, a maiden.

The use of silk as a material for clothing is of great antiquity, but it was very costly, so much so that we read in Roman history that the Emperor Aurelian, who died in the year 275 A.D., refused the empress a silk dress on account of its costliness.

Silk was first used in England about the year 1455, when a company was formed called silk winners. Most probably these were workers in silk. It was not, however, until 1685 that the manufacture of silk was established in London, when many French refugees who came to this country after the Revocation of the Edict of Nantes, settled in Spitalfields. The manufacture of silken goods is now carried on in several parts of England, and the quantity of raw silk used is very great. In 1868 as much as 7,036,177 lbs. were imported.

The fibres of the flax plant have been employed as a material for clothing from the very earliest times. It was in common use among the Egyptians in the time of the Pharaohs of the Bible, and among the paintings on the Egyptian tombs may be seen many representations of the flax plant, and the different stages in the manufacture of linen.

Whether the raw material used for clothing be silk, or wool, or flax, or cotton, it has to undergo several operations before it can be made into a garment: the most important of these are spinning and weaving. We will now describe these operations as they refer to cotton.

Cotton is the downy covering of the seeds of the cotton-plant, and is contained in the seed-vessel. The plant belongs to the natural order Malvaceæ, or Mallows, and of the genus Gossypium.

When the seeds are ripe, the pod opens, and the cotton is gathered by hand, great care being bestowed upon this operation. It is gathered as soon after the pod bursts as possible, and always in dry weather. The seeds are now separated from the cotton by a simple machine called a gin. When freed from the seeds, it is pressed into bags called bales, each bag when full weighing from 330 to 350 pounds.

When bought by the manufacturer, the cotton contains a great deal of dust. It has therefore to undergo the operation of cleaning; this process is called *willowing*. In this state the fibres of the cotton are placed in all directions, but before the cotton can be spun into a thread the fibres must be straightened. This is accomplished by first forming the cotton into a continuous sheet called a lap and resembling a sheet of wadding; and then by a process called *carding*. The carding-engine collects the fibres into a fine sheet, and then forms it into a narrow flattish band called a *sliver*. The fibres are not even now in a fit state to be spun, and so eight or ten of these slivers are united into one by the drawing machine. This process is repeated several times, and the cotton is said to be Drawing No. 1, 2, 3, and so on. Each time the cotton is drawn it is increased in length. This process is repeated again and again, under the name of *slubbing* and *roving*, the cotton being drawn out each time into a longer and thinner thread. When the *roving* is brought down to its proper fineness, it is *spun*—that is, the fibres are twisted and made into a strong thread. It is now called *yarn*. This process is a very important one, and used formerly to be performed by hand by what was called the spinning-wheel. Now, however, it is performed by a beautiful machine called the spinning-mule, or spinning-jenny. This machine was invented by James Hargreaves in the year 1764. It was afterwards improved by Richard Arkwright in 1769, and perfected by Samuel Crompton in 1779. Further improvements have been made in these spinning-machines, and the self-acting spinning-mule of the present day may safely be considered one of the wonders of the world. That such is the case will be seen by a few facts relating to the spinning of very fine yarns.

The thickness of the thread is expressed by numbers, as No. 40, No. 60, etc. up to 700 or even 1,000. These figures represent the number of hanks to the pound, the hank or *lea* as it is termed always containing 840 yards. At the present day linen yarn of No. 700 is sometimes spun. Now 700 leas of 840 yards each will equal 588,000 yards to a pound, or rather more than *three hundred and forty-six miles*. Yarn of this degree of fineness has been sold at 560 shillings per pound, or thirty-five ·illings per ounce, which is seven times the value of silver. The yarn having been spun is next woven.

Weaving is the art of making cloth by the interlacement of threads. It has been practised from the earliest times; and representations of hand-looms for weaving are found upon the tombs of the ancient Egyptians, constructed on the same principle as those in use at the present day.

If a piece of any plain woven material is examined it will be found to consist of two sets of threads, a set parallel to each other, and running the whole length of the piece of cloth, and these forming what is called the *warp*, and another set which passes across them at right angles in the direction of the width of the cloth, and which forms the *weft*. If the threads which form the weft are examined they will be found to pass alternately over and under those of the warp. The thread which forms the weft is a continuous one, being doubled back at the edge of the cloth, and on its return, passing *over* those threads it passed *under* before, and under those it previously passed over. Indeed, the arrangement of the threads is similar to that which is produced in darning.

The first process in weaving is to fix the threads of the warp. The length and width of the cloth having been determined, the threads are wound upon a roller and are laid parallel by an instrument resembling a comb. When a sufficient length of warp is wound on the roller, the unattached ends are fastened to another roller called the *cloth beam*. Before this is done, however, each alternate thread is passed through a loop in an instrument called a *heddle*. In weaving all plain cloths, two heddles are used. Each heddle consists of two horizontal sticks placed across the warp—one a small distance above, and the other below. These two sticks are connected together by a number of thin pieces of twine which pass perpendicularly through the threads of the warp. In the middle of each piece of twine a loop is made, and through this the thread of the warp is passed If the heddles be called one and two, and the threads of the warp be considered as representing the odd and even numbers, then heddle number one will contain the threads one, three, five, seven, nine, etc., and heddle number two will contain threads two, four, six, eight, ten, etc.

This process having been accomplished, the ends of all the threads are fastened to the cloth roller: the heddles are so suspended that they may be raised or depressed about two inches by means of a treadle moved by the foot of the weaver in hand-looms—or by a piece of machinery in power-looms. The two heddles are connected together by a cord passing over a pulley, so that when one is depressed the other is raised: and when this is the case half the threads of the warp will be pulled up by one heddle, and the alternate threads depressed by the other, leaving a space between them: through this space, which is called the *shed*, the thread of the weft is passed. As the position of the heddles is reversed the thread of the weft passes over and under the alternate threads, and so they are firmly interlaced. In order to pass the thread of the weft easily from side to side, it is wound on a small piece of wood, termed a shuttle, which is thrown across the warp, the thread unwinding as it proceeds. Each thread of the weft is pushed close together by an instrument called a *batten*. As the cloth is woven, it is wound on the cloth roller, and then taken to the finisher, or bleacher, or printer, as the case may be.

J. H.

WINDS.

e-qui-lib′-ri-um (L. æquus, libra), *equality of weight*
ve-lo′-ci-ty (L. velox), *swiftness*
ex-pan′-sion (L. ex, pando), *the act of spreading out, extent*
con-trac′-tion (L. con, tractum), *the act of drawing together*
rar-e-fac′-tion (L. rarus, facio), *the act of causing air to become thin*
ro′-ta-tor-y (L. rota), *a whirling*
trans-i′-tion (L. trans, itum), *change from one place or state to another*
ver′-nal (L. ver), *relating to the spring*
æ′-qui-nox (L. æquus, nox), *the times when the days and nights are equal—about March* 21 *and September* 22
vi-ce-ver-sâ (L.) *in a contrary way*
e-nu′-me-rate (L. e, numerus), *to number, to reckon up singly*
bane′-ful (S. bana), *poisonous, destructive*
im-preg′-na-ted (L. in prægigno), *made full of*
im-pal′-pa-ble (L. in, palpo), *that cannot be perceived by the touch*

WIND is caused by a change in the temperature of a portion of the atmosphere by which the equilibrium among its particles has been destroyed. To restore the equilibrium there is a rush of air towards the place where the balance has been destroyed, and this current or motion of the air is termed *wind.*

Winds are generally divided into three classes—*permanent*, or those which blow constantly in the same direction, and are termed 'trade winds;' *periodical*, or those which blow in certain directions at stated periods, as the monsoons; and *variable*, or those which depend on a variety of circumstances which cause the expansion or contraction of the volume of atmosphere, and of which our country furnishes daily instances.

The permanent or *trade winds*, so called from the advantages their steadiness and permanency afford to trading vessels, extend nearly thirty degrees on each side of the equator. As the sun's rays are almost vertical in the tropical regions, the rarefaction of the atmosphere is there greater than on any other portion of the earth's surface, and consequently constant currents of air from the parts less immediately exposed to the direct rays of the sun are moving in the direction of the equator. Winds coming from regions where the rotatory motion of the earth is much slower than that into which they enter, are left behind before they can acquire the new velocity, and, as they do not move eastward along with the earth, they will have the appearance of moving westward. It is only as they approach the equator that *trade winds* blow from the east; originally, they were north and south winds. Were the tropics entirely covered with water, the winds from the north would constantly blow in a north-eastern, and those from the south in a south-eastern direction. But the interposition of ranges of lofty mountains and of extensive plains of sand diverts them from their course, and renders them subject to sudden and almost unaccountable irregularities. This is the reason why *trade* winds are more regular in the Pacific than in the Atlantic, and in the Atlantic than in the Indian Ocean.

Monsoons, from the Malay *moossen*, a season, are so called because they blow regularly at stated periods—six months in one direction and six months in exactly the opposite direction. These winds prevail most in the Indian Ocean, and their change is always accompanied by violent storms.

Like the trade winds, the monsoons are dependent upon the sun. When the sun is north of the equator, that is, from the vernal to the autumnal equinox, these winds blow from the south-west; but while the sun is south of the equator, that is, during the remaining six months of the year, they blow from the north-east.

The reason is obvious. While the sun is north the equator, all the great plains of Hindostan, Arabia, Burmah, etc., are more heated than the Indian Ocean. Consequently the cooler and heavier air of the ocean rushes in to fill up the place of the lighter air which constantly ascends from these countries.

And as the air from the equator possesses a higher rotatory motion than the portion of the earth over which it must pass, it will have an opposite motion impressed upon it—that is, it will blow from the south-west, and *vice versâ* from October to April, when the sun is south of the equator.

The same causes produce the *land* and *sea breezes* of tropical climates. During the day the surface of the land becomes more heated than that of the adjacent sea, and the air above the land being consequently lighter, ascends, while the cooler and heavier air from the sea rushes in to supply the vacuum; but during the night the reverse of this takes place: the air above the land cools, more suddenly than that above the sea, and thus a breeze from the land towards the sea sets in. In many climates the heat would be perfectly insupportable were it not for these land and sea breezes.

The variable winds depend upon such a variety of circumstances, and extend over such an immense portion of the globe, each region having its distinct and peculiar cause or causes of changeability, that it would be absurd to attempt to enumerate the numberless causes by which they are regulated.

There are several winds of a peculiar and local character, such as the sirocco, simoom, samiel, harmattan, pampero, and typhoon, which deserve our notice.

The sirocco, which blows from Africa, occurs in Italy and Spain. Its effects are very distressing, producing a dryness of the skin, accompanied with great irritation of the nerves, and attended with unusual languor and dejection. Under its baneful influence vegetation droops and withers. Its duration varies from two hours to three days.

The simoom and samiel are peculiar to the deserts of Arabia and Africa. The word simoom is derived from the Arabic *samma*, to poison. These winds are the most terrible of all in their effects. They are generally impregnated with fine sand, which rises in such volumes as to hide the sun. Their approach is generally announced by a lurid appearance in the air, and camels seem instinctively to dread their effects, endeavouring to shield themselves from them by thrusting their noses into the sand, and travellers follow their example by covering their faces, and lying flat on the ground until they pass over, which they generally do in a few minutes.

The harmattan blows from the Sahara to the Atlantic at intervals from December to February. It produces excessive dryness; and though vegetation withers under its effects, yet it is conducive to health by purifying the atmosphere from those noxious vapours which at this time arise from the immense quantities of decaying vegetable matter.

The pampero is peculiar to South America. It blows from the south-west, and brings with it the cold air from the snow-clad regions of the Andes. This wind is occasioned by the rapid transition from heat to cold which so frequently occurs in those regions.

The khamseen is only met with in Egypt. It blows from the south, and 'raises the temperature like the blast of a furnace. It carries with it a quantity of impalpable dust, which penetrates every corner and crevice of the best built houses.'

Typhoons and tornadoes are principally confined to the Eastern seas, and are supposed to be occasioned by sudden and violent rarefactions of the air produced by electricity.

According to its velocity the wind is said to be a breeze, a gale, a storm, or a hurricane; and the rate of travelling per hour is from four to five miles for a breeze, from a hundred to a hundred and twenty miles for a hurricane, while the pressure per square foot is from one pound to one pound and a half for a breeze up to fifty-eight pounds for a hurricane.

Winds play an important part in the economy of nature; not only are they great aids to the commerce of the world, they are also the principal conservators of its health. They prevent the waters of the ocean from becoming stagnant; they cleanse the foul fœtid dens and alleys of large towns, they bring with them from the ocean moisture, which they carry to far-off regions to refresh the thirsty soil, and to render it fruitful and fit for man's abode.

W. M.

CAVERNS.

ar-ti-fi'-cial (L. ars, facio), *made by art, not natural*	va-ri'-e-ties (L. varius), *different sorts or kinds*
moun'-tain-ous (L. mons), *full of mountains*	di-vi'-sion (L. divido), *a separated part*
con-tin'-u-al-ly (L. con, teneo), *unceasingly*	fre'-quent-ly (L. frequens), *often*
ma-te'-ri-al (L. materia), *that of which anything is made*	mys'-ter-y (Gr. musterion), *something secret*

In the Bible frequent mention is made of caves or caverns in which individuals, and sometimes great numbers of people at once, were in the habit of taking shelter from their enemies or of hiding from justice. David, as you know, lived for a time with his 400 men in the Cave of Adullam; Elijah, too, after the slaughter of the priests of Baal at Mount

Carmel, went and hid in a cave at Horeb. The Canaanitish kings who fought against Joshua hid themselves, and were buried in a cave.

You will, perhaps, ask 'What is a cave?' Well, a cave is a hollow in the rocks, made either by nature or by man. The former is called a *natural* cave or cavern, the latter an *artificial* cave. Palestine, which is a very hilly and rocky country, abounds in caves of all sizes, some large enough to hold 1,000 men. Most of them are natural, but some of them have been enlarged from time to time by man as dwellings and burial-places.

But Palestine is not the only country in which caves exist. There are but few mountainous countries, if any, in which natural caverns may not be found. There are a good many caverns, and very interesting ones too, in different parts of the British Islands, as well as in France, Belgium, Germany, and America; most, if not all, of which have been inhabited at some time or other.

These caverns are most common in limestone districts; indeed, they are almost entirely there, the reason of which you will presently see. But you will probably say, 'I know what lime is of which we make mortar, but what is limestone?' Now the easiest answer I can give to that question is, that limestone is the rock which we roast in order to make lime, or that it is lime united with a poisonous gas or air called carbonic acid gas, which we and all animals are continually breathing out of our lungs, and which is produced whenever we burn a piece of wood, coal, candle, gas, or oil. When we roast the limestone or carbonate of lime, we drive out this carbonic acid gas, and lime, or, as it is called, *quicklime* remains.

Now there are a good many varieties of this carbonate of lime or limestone, some of which are chalk, marble, and a variety generally found in the coal districts called *mountain limestone*, forming, as it often does, bold high mountains. The shells of snails, mussels, cockles, oysters, and all the like are made up of this carbonate of lime, as are also all coral reefs, which are really mountains under the sea; and we may feel pretty sure that chalk and nearly all other limestone rocks were made in a great measure by sea animals.

It is in the mountain limestone rocks that caverns are mostly found—at any rate in Britain; and it is in the mountain limestone districts we must look for them. These districts lie chiefly in the north-west; for instance, the Cheviot Hills, the Pennine in Yorkshire and Derbyshire, Denbigh and Flintshire in North Wales, and Glamorganshire in South Wales, the Mendips in Somerset and a district near Torquay in South Devonshire; and it is in these places we find the caves, into some of which I have been, and one of which I will presently describe.

The British caves are situated in the side of the hill at some height above the sea, the bottom of the valley, or the plain below. You must not suppose they are regularly formed like the inside of an oven or a vault built by man. On the contrary, they are in general very irregular in their form. 'Kent's Hole,' in South Devon, has two narrow entrances, about fifty feet apart, on the side of a hill about sixty feet above the valley beneath, and 200 above the sea. Inside there are two divisions, like large halls, running side by side for some distance, and joined by a cross passage at the end. The length of one division is nearly 300 feet or 100 yards, in one place ninety feet wide, and twenty-two feet high. Each of the divisions has several galleries and chambers or side rooms.

Now, most caves are more or less like 'Kent's Hole;'

some of those in Derbyshire are much larger, one, the 'Devil's Cave,' being half a mile long; some also are very high in the roof. The roofs of many too are adorned with what look like huge icicles, but are really formed of stone, and are called *Stalactites*, which hang down a great way from the roof, making the cave look like a fairy palace when lighted up by the torch of the visitor. The floor also is frequently covered with a pavement of the same material, but called *Stalagmite*.

Caves were formerly places of great mystery and awe to the country people, who in consequence gave them strange names. Most of those in England, and in other countries too, have in later times been carefully examined by gentlemen who were anxious to find out their history, and that of their former inhabitants. And what these gentlemen have found in these caves makes them exceedingly interesting. Generally they are guarded by doors, which are always kept locked, and those who wish to visit them must pay for admission and for a guide.

But you will be anxious to know why limestone rocks should contain caves more than other rocks, and how caves were made. I will try to explain these things. If you will take a little quicklime of which mortar is made, dissolve some of it in a jug of water, allow it to settle, then carefully pour off the clear liquid into a bottle, you will have what is called limewater, which is a little rough to the taste. Now if you take a straw, and breathe through it into the limewater you will soon see the limewater, which was at first clear, become quite thick and milky. This milky substance is really chalk or carbonate of lime. The carbonic acid of your breath unites with the lime and forms chalk. But if, after the chalk is formed, you continue to breathe into the water, the chalk will disappear, and the water become clear again. A double quantity of carbonic acid *dissolves* the chalk.

Now water generally contains carbonic acid. Limestone rocks, too, are very often cracked in different directions, and, as the rains sink down through the limestone rocks, and as streams flow through these cracks, the water dissolves away the rock, forming in the course of a very long time these great caverns. You may often have noticed hanging down from the roof of a railway arch or of a bridge, even in summer time, long white things which you may have mistaken for icicles. Not long ago, a man told me he always thought they were icicles, and wondered how they could remain there during the summer. These icicles, as the man thought them, are really *stalactites*, like those which hang from the roof of a cavern—only, of course, very small ones. As the rain sinks through the joints of the stones or bricks, it dissolves the mortar, part of which is left behind in the stalactite as the water falls drop by drop. Much in this way the large and beautiful stalactites are formed in caverns.

But all the dissolved limestone is not left behind in the stalactite. Much of it falls in the water drops upon the floor beneath, and there the remainder is left to form a *stalagmite* floor, as the water is evaporated away. Often the pavement of stalagmite is several feet thick, which would require a very long time to form. Sometimes streams of water, fresh or salt, flowed for a time into or through the cave, carrying in and leaving there layers of earth and stones, to be again covered with more stalagmite when the water ceased to flow in. This is the case with many of the caves in England.

On examining these different layers, which have become in most cases very firm and hard, they are found to contain the bones of different kinds of animals, some of which, perhaps, fell in through the cracks above; others, perhaps, washed in by the water; but for the most part they were carried in there by man or other animals.

On the top, or in the top layer, are generally found the remains of many animals like those living now, mingled with the works of man from the present time to that of the Ancient Britons. But in the different layers below the remains are the bones of *extinct* animals, such as the cave bear, hyæna, tiger, rhinoceros, elephant, and of some formerly wild, as an ancient horse, fox, badger, various kinds of deer, like those which lived in the cold period, spoken of in a former lesson. With bones of animals which are imbedded in the stalagmite and other materials are found flint and bone instruments which were made and used by men who lived in times long before the Ancient Britons, and who did not know the use of metals. These men sometimes lived in the caves, fed upon the animals of the time, and sometimes amused themselves by drawing figures, and not at all bad ones, of the animals upon their bones. I have seen the horns of a reindeer found in a cave in France, upon which is drawn a pretty good picture of a reindeer. In one part of Kent's Hole cavern, below the top stalagmite, is a large patch of charred wood, where these very ancient men used to make their fires to cook their food, and perhaps, to frighten the wild beasts.

The hyæna, tiger, and bear used these caves as their dens when the men did not occupy them, and there they dragged the deer and other animals upon which they preyed, for the marks of their teeth are to be seen upon their crunched bones, and the sides of the entrance are often polished by the rubbing against them of the skins of the animals as they went in and out.

You may see large quantities of these cave remains in the British and Jermyn Street Museums in London, in the museums of the towns in the neighbourhood of the caves, and in the caves themselves; for portions of the layers are left to show the manner in which these animals were buried.

H. T.

RACES OF MEN.

sci-en-tif′-ic (L. scio), *relating to science*
re′-cent-ly (L. recens), *newly, lately*
con-fir-ma′-tion, (L. con, firmus), *convincing testimony*
cha-rac-ter-ist′-ic (Gr. character), *that which marks the character*
trans-for-ma′-tion (L. trans, forma), *change of form or character*
phys′-i-cal (Gr. phusis), *relating to the body*
in-tel-lect′-u-al (L. inter, lectum), *relating to the mind*
pro-gress′-ed (L. pro, gressus), *advanced*
pro-lif′-ic (L. proles, facio), *productive*
su-per-sti′-tion (L. super, sto), *false religion*

The varieties of the human race are so numerous that it would require much space to give even a simple list of them; but there are some races which possess differences so marked and distinct as to give the characteristics by which the whole are separated into certain divisions. In these the form of the skull, the colour of the skin, the character of the hair, &c., differ very widely, and attempts have been made by many scientific writers to prove that these varieties were created at different times. Even more recently it has been asserted by a naturalist of eminence that man was not created at all, but that he has gradually developed, through long ages, from one of the lowest forms of life; and that his varied powers and faculties have been slowly acquired as he had need of them. We trust our young readers know and believe their Bibles too well to be led away by such sad speculations; that they will remember the account of the creation of man given us in the first chapter of Genesis as the crowning marvel of God's divine power, and the declaration of the Apostle Paul in confirmation, that He 'hath made of one blood all nations of men, for to dwell on all the face of the earth.'

Firm in this belief, we will briefly notice some of the races which are most distinct in their peculiarities, first stating that it is well agreed that there is nothing in the differences that exist in stature, form of skull, features, colour of skin, &c., which would prevent us from concluding that all mankind have descended from a single pair, as related by Moses. Climate, food, habits of life, and other influences are quite sufficient to produce varieties, and, if continued, to cause them to be perpetuated. We have only to look around us, and we can see every day members of our own oval-headed white race whose skulls bear great resemblance to many of the more debased and savage races; and amongst the coloured ones we can often note those who vary from their type and approach in form the white race. This tendency to vary, from one cause or another, confirms the conclusion previously expressed.

Cuvier divided the human family into three races, Blumenbach into five; but Dr. Prichard, whose researches are the most recent, classes them into seven.

These are, *first*, the nations whose skulls and physical characters resemble Europeans, including many in Asia, and some in Africa; *secondly*, those resembling the Calmucks, Mongols, and Chinese; *thirdly*, the native Americans, including the Esquimaux; *fourthly*, the Hottentots and Bushmen; *fifthly*, the Negroes; *sixthly*, the Papuans, or woolly-haired and other tribes of Polynesia; and *seventhly*, the Alfourous and Australians.

The first, or white race, are pre-eminent for their physical powers, beauty of person, and intellectual superiority; and it is amongst them that civilisation and the arts and sciences have made the most progress, and attained the highest perfection. But amongst them there are great differences. We have the fair-haired and ruddy Anglo-Saxons, the swarthy Spaniards and Italians, the sallow Turks, the finely-formed Circassians and Georgians, celebrated for their personal beauty; the dark Afghans; the still darker Hindoos, and many others.

In the second we have the Calmucks and Tartars, inhabiting the rugged countries and extensive plains of central Asia, who wander about with their enormous flocks of sheep, and droves of horses; the inhabitants of Thibet, of which country we know so little; and the numerous and industrious Chinese. The latter possess a high degree of civilisation, have attained great skill in the arts, were the inventors of the mariner's compass, and yet have not progressed in either the arts or sciences. We are, however, much indebted to them for their patient industry, especially in the production of tea and silk.

The third race includes the Red Indians of North America, a fine hardy race, most of them wandering about, and obtaining food by means of hunting wild animals, especially deer and bison. With them also are the Esquimaux, a race short in stature, as though stunted by the cold and inhospitable climate of their country, which borders on the arctic regions. They live entirely upon animal food, clothe themselves in the skins of animals, use dogs to draw their sledges, and build themselves substantial houses of frozen snow, in which they pass their long arctic winter.

In the fourth race are the Hottentots of South Africa, a repulsive people, with olive-brown complexions, wide nostrils, and thick lips, possessing a low intelligence, which, however, under kind teaching, is capable of improvement, but who, in their native condition, live more like animals than human beings, gorging themselves with food when it is plentiful until they can scarcely move, and wearing no garments but a strip of cloth round the loins. With them too, and inhabiting the same country, are the Bushmen and Earthmen, beings the very lowest in the scale, living like wild animals in thickets, and holes in the earth, their highest thoughts being only how to supply their appetites.

The fifth is the numerous and oppressed nation of the Negroes. Their well-known characteristics are their dark skin, approaching black; short black, woolly hair; high cheek-bones, projecting jaws, and thick, prominent lips. They are a patient, long-suffering people, accustomed to servitude, both from their own chiefs, and from their white oppressors. They are a numerous and prolific race, inhabiting chiefly the northern and central parts of Africa. The Caffres and Fingoes of Southern Africa vary a little in having not so dark a complexion, and less prominent jaws and lips, and are more fierce and warlike in their dispositions.

The sixth race comprises people who differ greatly both in appearance and character. We have first the Papuans, inhabiting New Guinea, of small stature, and sooty skins, and remarkable for their woolly, frizzled hair, resembling mops. And we have also a lighter race, of olive or brown complexions and straight hair. This includes the Malays, and the numerous tribes inhabiting the lovely islands of the South Seas. Many of these latter are finely formed, and possess a large amount of personal beauty, but in their natural condition are cruel and savage cannibals. Christianity has, however, through the exertions of the missionaries, wrought wonders in the transformation of many of these people; and industry, morality, and religion have taken the place of idleness, licentiousness, and the most degrading superstition.

The seventh division includes the Alfourous of New Guinea and the natives of Australia. These, though greatly partaking of the character of the negro, especially in the colour of the skin, yet differ from him in many important points. They stand very low in the scale for intelligence, having few traces of religion or the worship of a Superior Being, and wearing little or no clothing, and are, moreover, cruel and degraded in their habits. They are not a prolific race, and are gradually diminishing in numbers.

Besides those enumerated, there are a great many intermediate races in all parts of the world, partaking partly of the characteristics of one, and partly of another; but, however widely these various peoples may differ from each other, we must agree with Dr. Prichard, 'that the sentiments, feelings, sympathies, internal consciousness, and mind, and the habits of life and action thence resulting, are the real and essential characteristics of humanity,' and prove that man is the special work of God's hand, and not the development of the brute.

W. J. S.

THE ARABS.

hos-til′-i-ty (L. hostis), *enmity*
ter′-ri-tor-y (L. terra), *land, country, dominion*
ac′-cu-rate-ly (L. ad, cura), *correctly*
en-ter-pri′-sing (L. inter, Fr. pris), *undertaking hazard*
en-du′-rance (L. in, durus) *patience*
de-vi′-sed (L. de, visum), *invented, contrived*
a-dapt′-ed (L. ad, apto), *fitted*
hos-pi-tal′-i-ty (L. hospes), *the practice of entertaining strangers or guests*
qual-i-fi-ca′-tion (L. qualis, facio), *accomplishment, endowment*
do-cil′-i-ty (L. docilis), *teachableness*

If we wanted any proof of the truth of the Bible, the Arabs afford us one which cannot be doubted. Of Ishmael, the founder of the race, it was foretold by God that He would make of him a great nation, and the character of this people as described in Divine words in Gen. xvi. 12, is very striking: ‘And he will be a wild man; his hand will be against every man, and every man's hand against him; and he shall dwell in the presence of all his brethren.’ No language could more clearly describe in few words the Arabs of the present day. They are hardy, untamed freebooters, living in hostility with all, defying the most powerful nations, and never have been conquered. The Persians, the Grecians, the Romans, the Tartars, and the Turks have in turn attacked them, but have never been able to overcome them, or to deprive them of their freedom, and they roam about their vast territory with no one to say them nay.

Their mode of living, too, is described as accurately as their character in the verse above; the Hebrew word translated ‘dwell’ signifies to ‘tabernacle’ or dwell in tents, a practice which is followed by the greater number of the modern Arabs.

Their wealth consists in their horses, camels, and sheep, and they shift their tents from place to place according as the abundance or scarcity of pasturage renders removal necessary.

A small number dwell in towns and engage in trade and commerce, in which they are very enterprising.

Their territory stretches from Aleppo to the Arabian Sea, and from the Persian Gulf to Egypt; and beyond this they have spread themselves over the entire northern part of Africa.

The Arabs are known amongst themselves by the name of Bedouin, or, as spelt by some travellers, Bedaween, which is derived from the Arabic word 'badw,' a desert, 'badwi' being an inhabitant of the desert.

Before the time of Mohammed there was no union of the various tribes, and their religion appears to have been the worship of the sun and moon, or other of the heavenly bodies; but when he, in A.D. 640, declared himself the prophet of God, and devised a new religion, all the tribes accepted it, and, in obedience to their prophet's command, made it one of the principles of their faith to compel all with whom they came in contact to become Mohammedans.

The habits of the wandering Arabs of the present day being necessarily adapted to the nature of their country and mode of life, are of a very simple nature, and have scarcely suffered any change from the days of Ishmael. They are noted, as of old, for their hospitality, horsemanship, expertness in the use of arms, and for their eloquence; and these qualifications are highly valued by them.

The government of their tribes is patriarchal, the chief being called a sheik, possessing supreme power, ruling over their families and all their servants and dependents. If the tribe is only a small one, it will join with others under the leadership of a more powerful sheik, in order to defend their property against hostile neighbours. Though united as one people by the bond of religion, the various tribes are constantly at war with each other. Each Bedouin is therefore, as it were, a born soldier, and becomes expert in the use of arms and in horsemanship from a child; for these are necessary to his existence.

The larger tribes possess great numbers of camels, part of which they use in war, part in transporting the goods of merchants, and part for sale. The smaller tribes keep sheep, and are less wealthy, while the lowest of the people attend to their rude agriculture.

High and low, they are all highway robbers, pillaging all unfortunate travellers who may fall into their hands. The protection of the pilgrims who annually visit the tomb of Mohammed at Mecca, is purchased by the Turkish Government of the tribes through whose territory they pass, all the chief tribes claiming certain districts, within which they exercise supreme power.

The tents of the Arabs are made of camel's hair, woven by the women into a coarse cloth of so dark a colour that at a distance they look black. The smaller tents have no division; the larger ones, and especially those of the sheik, are divided into several compartments. No tables, or chairs, or even bedsteads are used, a piece of carpet or a straw mat being used for the former, while the bed is a mattress spread on the ground. Their dishes are usually made of wood or copper, their cooking vessels being also of copper, as well as their drinking cups, all these being carefully tinned.

In cooking they build their fire on the ground and surround it with a few large stones, on which the pot is placed. Their corn is ground by the women a small handmill of two flat stones, one of which is turned about upon the other, and the flour is usually made into thin cakes, which are baked on an iron plate over the fire.

Their water vessels are made of the skins of goats, and are very durable, but when new impart an unpleasant flavour to the water.

No knives, forks, or spoons are used at their meals, a large dish being placed in the midst of the family, and each person helps himself by conveying with his fingers a portion of food into his mouth.

A modern Arab sheik presents to us in personal appearance a picture of what Abraham and Ishmael were in olden time, for the same manners and dress prevail now as then, the same out-door life and love of freedom; even their expressions and mode of address are just such as are given us in the accounts of the patriarchs in the Bible.

The Arab is passionately fond of his horses, which are the most celebrated in the world, and he will not part with any of his most celebrated breeds for any sum of money. They are brought up with his children, sleep in his tent with them, and perhaps are more cared for than they. The most noted breeds are remarkable for their swiftness, endurance, and docility.

W. J. S.

THE ASSYRIANS.

mon′-u-ment (L. moneo), *a tomb, a memorial*
re-cord′-ed (L. records), *registered, enrolled*
sub′-se-quent (L. sub, sequor), *following in time or order*
pre-dict′-ed (L. pre, dictum), *foretold*
in-scrip′-tion (L. in, scriptum), *something written or engraved*
mi-rac′ u-lous-ly (L. miror), *in a miraculous manner*
suc-ces′-sive-ly (L. succedo), *one after another in order*
in-ter′-pret (L. interpres), *to explain*

On the east of Asia, rising in the Armenian Mountains, and flowing south into the Persian Gulf, are two rivers, known for ages as the Euphrates and Tigris, the latter supposed to be the Hiddekel mentioned in Genesis. These rivers flow through a large plain enclosed by high mountains and the sea, and finally unite their waters before reaching the coast. To this plain is given the name of Mesopotamia, and in ancient times it comprised three great countries—Assyria at the north, the district usually called Mesopotamia on the west, and Babylonia on the south. Assyria was situated beyond the Tigris; it is an elevated district, and bounded on the north and east by chains of mountains. The soil was generally fruitful. Rabshakeh, the Assyrian general sent by Sennacherib against Hezekiah, described it as a land of corn and wine, a land of bread and vineyards, a land of olive oil and honey. Its boundaries and extent differed at different periods. In early times it was probably a small district on the left bank of the upper Tigris, but it gradually extended to the mountains.

Assyria is supposed to have derived its name from Asshur, the second son of Shem. The prophet Micah calls it the land of Nimrod. We read in the early part of the Book of Genesis that 'Nimrod was a mighty one in the earth,' and that he built Babel, and other large cities, and afterwards that he went out of that land into Assyria and built Nineveh and several other cities. These Assyrian cities are shown by history, and by monuments recently discovered in that country, to have been peopled from Babylonia. We afterwards read of Nineveh when Jonah, who is considered the earliest of the prophets, was sent on his mission. From this time it would seem that the inhabitants extended their dominion under several kings, whose names are not certainly known, but whose exploits in war are found to be recorded upon monuments brought from that country, and now in the

British Museum; subsequently to this, the history of the Assyrians is more or less connected with that of the Israelites.

The first Assyrian monarch mentioned in Scripture is Pul, who invaded the kingdom of Israel, and his forbearance was purchased by a thousand talents of silver. He seems to have been a powerful monarch, and to have received tribute from a good number of the neighbouring nations. He was succeeded by Tiglath-Pilezer, who also invaded Israel, and received tribute from Ahaz, whom he helped against the Syrians and Edomites. He stormed Damascus, the capital of Syria, and removed the people beyond the Euphrates.

His successor was Shalmanezer, who advanced with an immense army against Samaria, the capital of the kingdom of Israel, and laid siege to it. For three years the city held out against him, and, according to some inscriptions, was at last taken by his successor Sargon; the Bible simply says 'the King of Assyria.' It seems to have been the policy of the Assyrians, when they conquered a country, to lead the inhabitants away captive, and colonise it with tribes from another district, thus greatly enlarging and strengthening their empire. The greater part of the ten tribes of Israel were carried away into captivity, and the Assyrian monarch, after overrunning Egypt and Phenicia, laid siege to the famous seaport of Tyre, and even seized upon the throne of Babylon.

Sennacherib, who succeeded Shalmanezer, enlarged and beautified Nineveh, and made it his capital. The wars of this king were more extensive than those of his father. He passed through Syria, Phenicia, and Samaria, ravaging and overthrowing towns and villages, and penetrated into Judea. On Hezekiah agreeing to pay him tribute, he made an expedition into Egypt, and on his return again sent up a large army against Jerusalem with a blasphemous message against God. Immediately afterwards his vast army was miraculously destroyed by the God whom he had blasphemed, and he himself fled to Nineveh, where he was murdered.

Esarhaddon, his son, who succeeded him, was probably the most powerful of all the Assyrian monarchs. During the first year of his reign he was a great conqueror, and led his armies over all the neighbouring countries, and united the city of Babylon to his dominions. He conquered the country of Judah, and was at Babylon when Manasseh was brought to him captive from Jerusalem. This king built a great number of palaces and grand buildings, and the kingdom of Assyria was, in his reign, at the height of its power and glory. He is the last Assyrian king mentioned in Scripture. Soon after this, the power of this monarchy began to decline, and the neighbouring nations of Media and Babylonia began to increase in importance, and about the year 625 B.C. the Medes laid siege to Nineveh, took it, and thus put an end to the Assyrian monarchy. This had been prophesied long before by the prophets Isaiah, Nahum, Zephaniah, and Ezekiel. Since then the country has successively belonged to the Greeks, Romans, Persians, Saracens, and Turks. Several large cities are mentioned in Scripture as belonging to the Assyrians. Nineveh, the capital, was built on the Tigris, and in the time of Jonah is spoken of as 'an exceeding great city of three days' journey.' It was surrounded by a wall 100 feet high, and wide enough for carriages to be driven abreast on it. Its population must have been very numerous, and the prophet Nahum speaks of its merchants as being more in number than the stars of heaven. It was taken by the Medes, and for a long time its site was unknown, but during the last half-century, recent travellers, especially Layard, have discovered its remains, and treasures of antiquity, concealed for ages beneath mounds of earth, have been recovered, and much knowledge gained of the customs and religion of the inhabitants of this once famous place.

Many of the sculptures, instruments of war, and domestic articles, in a good state of preservation, are now in the British Museum.

Other cities mentioned in Scripture are Calah, Rehoboth, and Resen. The sites of many considerable towns have been discovered by recent travellers, but the country is now an immense waste, with the exception of a few spots where small towns have been built.

The Assyrians were ruled by a despotic monarch. The king's will was law, and he often claimed Divine worship, as if he were a God. He was surrounded by great officers, who were ever ready to execute his commands; and, like the King of Egypt, had about him soothsayers and magicians, who pretended to foretell future events, and interpret dreams. The religion of the Assyrians was an idolatry of the worst kind, and their religious worship mixed up with sin of every description. They worshipped the sun, moon, and stars, as well as idols, supposed to represent the heavenly host. Baal or Bel was their supreme god. The prophet Nahum, who predicted the destruction of Nineveh and the overthrow of the empire, speaks of the prosperity and magnificence of the Assyrians while prophesying of their ultimate downfall. The country now forms part of Asiatic Turkey.

THE CHINESE.

mé-chan'-i-cal (Gr. mechanè), *pertaining to machinery or hand labour*
op-por-tu'-ni-ty (L. ob, porto), *fit time*
em-broid'-er-ed (Fr. en, broder), *adorned with figure needlework*
rev'-er-en-ced (L. re, vereor), *regarded with reverence or great respect*
art'-i-san (L. ars), *a mechanic*
ob-lique' (L. ob, liquu), *indirect, deviating from a right line*
con'-i-cal (Gr. konos), *having the form of a cone*
fas-ci-na'-tion (L. fascino), *unexplainable influence*

The people of China are one of the most singular races of men. They possess a very large amount of civilization; are clever, industrious, and ingenious in various mechanical arts, and keen in trading, while their books are some of the oldest in the world; and yet with all this they are sunk in idolatry and superstition. They consider there is no people like themselves, with great contempt calling all other people 'outside barbarians;' but for a long period, they would allow no foreigners to enter their land. Gradually these hindrances to our knowledge of the people have been broken down, and, though they have been compelled by war to admit foreign nations to trade with them in a fair and liberal manner, yet they still nourish hostility towards Europeans, and take every opportunity of showing it. China is more than fifteen times as large as England, Scotland, and Ireland put together, and the number of its people is greater in proportion than any other country in the world, and amounts to nearly 500,000,000.

About 200 years before Christ, the Chinese built an immense wall along their northern border to keep out their warlike neighbours the Tartars, and for a long time it was of great service, but at last, about the time of our Charles I., a Tartar chief conquered a great part of the country, and began to reign in 1644 as emperor in Pekin, the capital city. Since then, the royal family, and the principal civil and military officers, and most of their soldiers, have been Tartars; and though the two races live together they do not like each other, and many attempts have been made by the Chinese to defeat the Tartars and have a ruler of their own nation. The Tartars are forbidden to engage in trade, so the merchants and shopkeepers are all Chinese.

The emperor thinks himself superior to any one else in the world. He dresses in a yellow robe of silk embroidered with dragons, and no one else is allowed to wear the same colour; everything belonging to him is marked with a dragon. His will is law, and if he sends a written order anywhere, it is reverenced as much as himself. The various rulers and governors appointed by the king are called Mandarins, and they possess a great deal of power; another class of men are the learned ones, called literati, and every year there are examinations in all the towns, where thousands of students are examined. They do not, however, learn useful knowledge, as the boys in England do, but only study the ancient writings of Confucius, their most celebrated author, and are examined to see how much they know of them.

The country being very thickly populated, there is no large extent of ground set apart for pasturage, except on the hills, but every foot of ground is carefully cultivated for the production of rice, corn, and other plants for food; for their plantations of tea, and mulberry trees—on the leaves of which they feed their silk-worms: tea and silk being the chief articles of their commerce. The carpenters, blacksmiths and other artisans, are very patient in their work, but do not show much energy. The

Chinese are noted for their carved work in wood and ivory, and a man will often spend a very long time over an elaborate piece of carving.

In appearance, the Chinese are not attractive, according to our tastes. Their complexion is brownish-yellow, and the hair and eyes are always black; their faces are broad and flat, their eyes small and oblique, and the nose flat. The men shave off the hair from the front of the head, and gather the rest together, plaiting it with silk or artificial hair into a long tail. The labouring classes generally wear dresses of blue cotton, and a cap of cloth or strips of bamboo; or if they work in the fields, a conical cap of straw. The richer classes wear robes of silk in summer, beautifully embroidered, and of cloth in winter, bordered with fur. The women of all classes dress very modestly, their upper garment fitting closely round the neck, and their loose trousers reaching to the ankles. All the Chinese women of the better classes, and almost all who live in the towns, have their feet tightly bound up when they are infants, to make them small; this, of course, deforms them, and renders it very difficult for them to walk, but it is a fashionable custom; and many other people besides the Chinese do things equally foolish from the same motive. The Tartar women do not follow this absurd practice, nor the women of the country who work out of doors.

The Chinese are very fond of their children, and pet them very much when they are little ones, but boys are always thought more of than girls, as the latter are considered less serviceable when they grow up. In some parts the shocking practice of killing the female babes is very common. Boys are sent to school when about eight years old, and their sisters generally study with them until they are twelve or fourteen. Their school hours are very long, and they have few games, like English children. They are early taught to worship their idols and practise heathenish rites; but our missionaries are labouring hard to convey to them a knowledge of Christianity. The great difficulty in our intercourse with this people is, that they have two languages, one in which they converse, and another in which their books are written, and the latter contains about 4,000 different characters.

The houses of the Chinese are either built entirely of wood, or with wooden frames, filled in with mud and stones, combined with straw. The windows look into a central court, but these windows are of lattice-work, which, like the rest of the wood, is gaily painted and varnished. The rooms have no fireplaces, but metal dishes of charcoal are used in winter to keep the feet warm. The floors are covered with matting, and straight-backed chairs and little tables are placed round the principal room, while gay paper lanterns hang from the ceilings. The ladies receive their female visitors in their bed-rooms. The latter contain large wooden bedsteads, with a bottom of sacking, and on this the inmates sleep; in winter a thin mattress is added for warmth. They have no sheets or blankets, but counterpanes of silk or cotton, with cotton wool quilted in them; and a small, hard pillow completes the bed furniture.

Their mode of taking their meals differs widely from ours. They have no table-cloth, nor do they use either knives or forks, or plates or dishes. Their food is brought in small basins, and out of these they eat it with two chopsticks—slender pieces of bamboo or ivory, about nine inches long, which they hold between their fingers. Their food consists of a great variety of things, which sound strange to our ears. Pork is their favourite meat, but in addition to poultry they eat fish, frogs, young dogs and cats, and other articles, while their luxuries are soup of swallows' nests, sea-slugs, sharks' fins, &c. Sometimes the rich people drink wine with their meals, but the general beverage is weak tea, without either sugar or milk. In all the towns, tea shops are abundant; and though there are shops where wine is sold, yet it is little used, and it is rare to see anyone drunk. One sad habit, however, we must not omit to mention, and that is opium-smoking. This habit possesses a strange fascination, and once commenced it is seldom abandoned until death closes the scene.

Their worship of idols has been mentioned, their gods being the 'three precious Buddhas.' Of this worship they are very tenacious, and carry it with them wherever they go. Of late years the working classes among the Chinese have shown considerable enterprise, thousands of them having left their own country to find remunerative employment in California, Australia, and other newly-colonised countries. Being industrious and intelligent, their services are much valued by employers, especially as, from their frugal habits, they work for lower wages, while they save more money, than the labouring classes from Europe.

I. W. S.

EGYPT.

na-tion-al'-i-ties (L. natum), *people formed into nations*

prim'-i-tive (L. primus), *original, ancient*

con-spic'-u-ous (L. con, specio), *eminent, distinguished, obvious to the sight*

in-con-tro-vert'-i-ble (L. in, contra, verto), *that cannot be questioned, or changed*

as-tron'-o-my (Gr. aster, nomos), *the science which treats of the heavenly bodies*

ir-ri-ga'-tion (L. in, rigo), *the act of watering*

im-mor-tal'-i-ty (L. in, mors), *exemption from death*

per'-ma-nent-ly (L. per, maneo), *lastingly*

re-an'-i-mate (L. re, anima), *to restore to life*

prob-a-bil'-i-ty (L. probo), *likelihood*

sub-ter-ra'-ne-ous (L. subter, terra), *being under the surface of the ground*

in-un-da'-tion (L. in, unda), *a flood, a deluge*

As far as we can learn from ancient history, Egypt seems to have been one of the very first nations of the world to emerge from the state of primitive barbarism, and become conspicuous in learning, in arts, in arms, and the general attributes of a high state of civilization.

The Pyramids are, perhaps, the most remarkable among the many exceedingly remarkable remains of Egyptian art, power, and magnificence. These structures afford incontrovertible evidence of the progress which, at a very early period, must have been made by the Egyptians in the science of astronomy, for the four sides of the great pyramid are turned exactly to the four quarters of the world, and consequently show the true meridian of their site. When, and for what purpose the pyramids were erected has been a subject of dispute ever since the first dawn of history. Josephus, the great Jewish historian, suggests that they were erected by the Israelites during their bondage in Egypt: but the circumstance of the pyramids being built of huge stones, whereas we are told in Scripture that the structures erected by the Israelites were of *brick*, conflicts seriously with the opinion of Josephus. It has also been suggested that the pyramids were originally erected as granaries for the corn of the seven plenteous years foretold by the patriarch Joseph. The true origin of these stupendous edifices seems, however, to have been based upon the principle of belief among the Egyptians in regard to the immortality of the soul. It was a tenet of their religious faith that the soul would never permanently desert the body as long as that body continued to be preserved from decay, but, on the expiry of a thousand years, would return to reanimate the mortal frame once more. This was the origin of the practice of embalming, which was practised to such an extent among the Egyptians and with such wonderful success that *mummies*, as the embalmed bodies are called, are to be found in perfect preservation in the antiquarian museums and elsewhere, in every country of the civilized world. Strange leather-like forms these mummies are, and certainly suggestive of the most solemn and awful reflections! There is much probability that at least one of the purposes of the pyramids was to form a receptacle for the mummies of the illustrious dead, and many hundreds of mummies have been found in their gloomy and ancient cells. It may safely be asserted that the least remote antiquity of the pyramids must be three thousand years, since Herodotus, the earliest profane historian, and who lived about two thousand three hundred years ago, found them to be, even in his day, of an antiquity to which his researches could not reach; and Diodorus, who lived before the Christian Era, supposes the great pyramid to have been built a thousand years before his time.

By the testimony of ancient history 360,000 men were employed in the erection of the first pyramid, and a sum corresponding to nearly 500,000*l.* of our modern money was expended upon such edibles as garlic, onions, and leeks for the workmen, a fact which gives us some insight into the seasonings which were in popular use among the Egyptians.

The Labyrinth is also one among the most wonderful of the remains of ancient Egypt. It contains 3,000 chambers, 1,500 of which were subterraneous, and set apart either for the sepulture of the kings, or as abodes for the sacred crocodiles; for not only did the Egyptians worship this dangerous and repulsive creature, but also a long list of animals such as the cat, the ox, and the vulture. They, moreover, had sacred leeks, and various other kinds of vegetables.

The lake Mœris, too, has always been accounted one of the most remarkable relics of the ancient world. It was constructed by an early Egyptian king called Mœris, in order to supply water for the irrigation of the soil when such could not be obtained by the overflowing of the Nile, upon the inundations of which river, as is well known, the fertility of Egypt principally depends.

Education was confined to the priesthood, who instructed the youth in the principles of their religion, as also in geometry, arithmetic, reading, and writing. Another mode of writing, however—the 'hieroglyphics,' or *holy carving*—was known only to the priests themselves The attempt to decipher these hieroglyphics—many of which are to this day found upon the obelisks and other monuments of the ancient Egyptians—has long occupied, with some striking results, the attention of the learned world.

W. S. R.

THE PYRAMIDS.

com-mune′ (L. con, munus), *to hold intercourse with*
vague′-ness (L. vagor), *indefiniteness*
Cam′-by-ses, *a King of Persia who conquered Egypt*
Se-sos′-tris, *a famous King of Egypt, who made great foreign conquests*
Mis′-raim, *an ancient name for Egypt*
sym′-pa-thies (Gr. sun, pathos), *feelings in unison with*

Oh, pomp and pride of littleness,
On Misraim's ruined shore,
What dreams of Time's dim morning come,
In trouble, guilt, and gore,
And glide in spectral awfulness,
In long and shadowy file,
Above the giant wreck of Thebes,
Adown the stream of Nile!

The mountain tombs o'er royal worms
Their shadows fling afar
Beyond me on the barren sand,
Lit dim with moon and star,
Till I become as part of them—
Time, earth, and being seem,
Not real and stern, but shadows
In a dark and silent dream.

But this dream's every hour is worth
A mortal year of waking;
I feel, amid the desert's hush,
My soul its grooves forsaking
To commune with the eternal stars,
In grandeur, vagueness, awe:
The stars that o'er these Pyramids
Of old Sesostris saw.

Keen, cold, they gaze into my heart,
Through where the clouds are riven,
My naked soul lies spread before
The million eyes of Heaven,
Until I may forget I stand,
Where erst Cambyses trod,
And o'erlook the ghosts of heroes,
Alone with Night and God.

So, up that awful Pyramid,
My spirit seems to climb,
As on a Bethel ladder,
From the memories of Time;
And scaling o'er the mummy,
My daring hands unroll
The eternal shades which hide from us,
With God, the mummy's soul.

Keen sympathies of being,
Which were untouched before,
Start into life within me,
The ages bending o'er,
To gaze on spectral awfulness,
In long and shadowy file,
Sweep ghostly over Mœris' lake,
And down the stream of Nile.

W. S. R.

THE PERSIANS.

au-then′-tic (Gr. authentes), *having authority as true*
des-cend′-ant (L. de, scando), *the offspring of an ancestor*
con-tem′-por-ar-y (L. con, tempus), *a person living at the same time with*
in-tel-lect′-u-al (L. intelligo), *belonging to the intellect*
ca-par′-i-son (Fr. caparaçon), *the covering of a horse*
in′-cul-cate (L. inculco), *to impress by frequent teaching*
ac-com′-plish-ment (L. ad, con, pleo), *ornament of mind or body*
in-dic′-a-tive (L. in, dico), *showing, pointing out*
com-pound′-ed (L. con, pono), *made up of*
mul-ti-pli′-ci-ty (L. multus, plico), *greatness of number*
in-com-pat′-i-ble (L. in, con, peto), *inconsistent*

Persia, or Iran, the Elam of Scripture, is one of the earliest nations which we find occupying any prominent place in the annals of the world. Its early history, or rather historical legends, are, as might have been expected, of that grand and vaguely romantic character which appeals so pleasingly to the imagination, but which proves so misty and uncertain when we attempt to glean the bare facts of authentic history from them.

The first King of Persia is said to have been Caiumeras, whom some Oriental scholars have identified with the first man, or Adam—such is the distant origin claimed for Persian history. Some writers have, on the other hand, considered Caiumeras a near descendant of Shem, the son of Noah. Be this as it may, it seems that he was at all events the earliest King of Persia. A worthy king he seems to have been too, for, finding himself placed amid the primitive barbarism of the world, he undertook the arduous task of civilizing mankind, whom he instructed in useful arts. He subdued the Deeves, whom the poets describe as hideous monsters with claws and tails, but who were probably the barbarous inhabitants of the northern regions. By certain of the Oriental writers this early champion of civilization is reckoned as a contemporary of the prophet Edris, or Enoch, while others have supposed him to be the Chedorlaomer who is mentioned in Genesis in connection with the patriarch Abraham.

The successor of Caiumeras introduced the art of working metals, somewhere about nine hundred years before Christ. This king, Husheng, is also believed to have been the inventor of the saw and the axe, as also the first person who discovered that sparks could be struck from flint, a hint which it is supposed gave origin to Fire Worship, one of the most strange phases of idolatry which has ever been adopted by man in the innate yearnings of his soul after deity, and in that soul's mysterious conceptions of an existence beyond the grave. In this or some other extremely remote period, the Ghebers, or Fire Worshippers, took their origin, and even in the religious and intellectual light of this nineteenth century there are Fire Worshippers in Persia, and there are sacred fires smoking upon the huge rock altars of the land, which perhaps have never been even once permitted to expire during the lapse of thousands of years.

Zahmarus, the successor of Husheng, is believed to have been the inventor of armour and of the military caparisons of horses. Nor did he, amid the triumphs of war, overlook the great but bloodless victories of peace and progress; for no less an accomplishment than the art of expressing language by *writing* is set down to his inventive genius. Even about this distant period, the manufacture of cotton, silk, and linen seems to have occupied the Persian looms. The stupendous ancient city of Persepolis seems to have been, if not founded, at least vastly extended at this time, and some of the more advanced rules of social order seem to have been acted upon—all indicative of the progressive energies of a great and enterprising people. The population became divided into four distinct classes: men of learning—which class included the priesthood—soldiers, husbandmen, and artisans. The use of the solar year was also introduced Some have supposed that the religion of Enoch continued for long *the* religion of Persia; but the truth seems to be that fire from at first being regarded as only the visible semblance of the invisible God of Enoch, had, in course of time, come to be regarded as perhaps almost God himself. The celebrated Zeratusht, or Zoroaster, seems not to have founded, but simply to have changed or reformed, a religion which he found compounded of Sabæism and Fire Worship. He abolished certain superstitions and introduced others with new ceremonies and forms of prayer. To him, perhaps, may be ascribed the system of One First Principle with two secondary, Ormayd and Aheriman, Good and Evil, as also a multiplicity of inferior spirits. But the worship of one invisible and mighty Creator under the visible symbol of fire, and the doctrine of rewards and punishments in a future state, the deformity of vice and the excellence of virtue, which he inculcated, were acknowledged in Iran long before the age of his mission. Zoroaster lived about five hundred years before the Christian Era. He announced himself a prophet; endeavoured to prove his Divine mission by miracles, and exhibited his Zend, or Zendavesta, the Persian Bible, written in letters of gold upon twelve thousand skins of parchment, which, when the then Persian king, Darius Hystaspes, embraced the doctrines therein set forth, was, with religious care, deposited by him 'n the castle of Persepolis.

To record even a brief outline of the military conquests of the Persian arms, and of the enactments of the Persian kings and legislators, would be quite incompatible with the purpose and limits of a mere sketch like the present. Under Darius and other conquering kings, Persia rose to occupy a most prominent place among the aggressive military powers of the ancient world, sustaining few reverses, except at the irresistible hands of Alexander the Great and the heroic armies of Greece. As illustrative of how the original Persian territories were extended by conquest, we may quote the following legend, which in its wild extravagance yet bears a certain weighty significance. A certain Persian king, said to be a contemporary with the prophet Moses, agreed in treaty of peace with the King of Asiatic Tartary that the limits of the new territories to be added to the Persian Empire were to be determined by a bow-shot. Accordingly, a certain archer of the Persian army climbed to the summit of a hill in Tabariston and discharged an arrow with such force that it reached the banks of the river Oxus, a distance of over five hundred miles!

About the middle of the seventh century the Persians were called upon to offer a patriotic resistance to an invasion by the followers of Mohammed, who offered the two alternatives of death by the sword or conversion to the faith of the Koran. The Fire Worshippers offered a brave but ineffectual resistance—the Koran triumphed over the Zendavesta, although in ancient Iran the Ghebers yet worship with pious devotion, and the inextinguishable fires of their faith yet burn upon the rocks of their native land.

W. S. R.

THE GHEBER'S GRAVE.

myst′-ic (Gr. musterion), *obscure, secret*
bale′-ful (S. beal), *sorrowful, destructive*
de-vour′-ed (L. de, voro), *eaten up ravenously, consumed*
pol-lute′ (L. polluo), *to defile, to taint, to corrupt*
in-fect′ (L. in, factum), *to taint with disease*
mas′-sa-cre (L. massa), *slaughter*
con′-quer-ing (L. con, quæro), *overcoming, subduing*

No dismal Tower of Silence[1]
  Shall have me rotting there;
I'll write in Moslem life streams
  The valour of despair:
Ere o'er yon stern and holy rock
  The rising sun has rode,
I'll leap into the fiery arms,
  E'en of the Gheber's God.

Ere Zoroaster had been born,
  From that rock flames arose,
And now that fire, in God-like ire,
  Glares down on Iran's woes;
Chedorlaomer's eye beheld
  Its broad and mystic glow,
O'er Elam shine with flash divine,
  Thousands of years ago.

From the distant height it shone to him[2]
  Who led the wandering bands,
By day and night, with cloud and light,
  Across the Arabian sands:

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[1] The dead are conveyed to a place called in the Persian language *The Tower of Silence*, where the corpses are devoured by birds of prey, that the putrid remains may not pollute the earth or infect the air.

[2] Moses.

It shone that night with baleful glare
  When satraps thronged the hall,
And the exiled Hebrew prophet[1] read
  The writing on the wall.

And shall its lustre now be dimmed
  By the Camel-Driver's horde ?—
Darius, yield thy conquering blade,
  O Cyrus, lend thy sword:
Arise, O ghosts of Marathon,
  A worse than Greek is here;
Wake, spirits of the mighty dead,
  And grasp the Persian spear!

The Mecca Camel-Driver's moon[2]
  Waves in the plain below.
Oh, gods, they come, cymbal and drum-
  Dash, Iran, on thy foe!—
The spirit-ranks of Persia's dead
  Have left their glorious clay,
And all the brave, from o'er the grave,
  Shall aid your blades to-day!

. . . . . .

The weapons dripped with massacre,
  And fast the Ghebers fell,
While o'er them, from the frowning rock,
  The fire raged fierce as hell.
Despair—Despair! Hope lights no more
  The battle-crimsoned sod;
Bleeding and faint, the Gheber chief
  Draws near the fire of God.

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[1] Daniel.

[2] The crescent moon was the insignia in the Mohammedan standard.

Into the flames he hurled his sword
And mantle dyed in gore;
That arm of might, in Iran's fight,
Could wield the sword no more.
He on the furnace-altar leapt—
Clouds, smoke became his grave;
And so for God and Iran died
The bravest of the brave!

W. S. R.

THE GREEKS.

en-vel′-op-ed (Fr. envelopper), *enwrapped, covered*
im-pen′-e-tra-ble (L. in, penetro), *that cannot be pierced*
le′-gen-dar-y (L. lego), *fabulous*
ven′-e-rate (L. veneror), *to regard with respect mixed with awe*
myth′-i-cal (Gr. muthos), *fabulous*
in-vin′-ci-ble (L. in, vinco), *unconquerable*
ar-chi-tect′-ure (Gr. arche, tecton), *the science or art of building*
en′-ter-prise (L. inter, Fr. pris), *an undertaking of hazard*
con-for-ma′-tion (L. con, forma), *shape, structure*
in-sti-tu′-tions (L. in, statuo), *laws*
con-sol′-i-da-ted (L. con, solidus), *formed into a state of compactness*
con-cen′-tra-ted (L. con, centrum), *driven into a common centre, brought into a narrow compass*
pol′-em-arch (Gr. polemos, arche), *a ruler of the war*
dis-so-lu′-tion (L. dis, solvo), *the act of melting or breaking up*

The early history of the Greek nation is purely mythical, and it is not easy in wading through their records to assure yourself when you have reached solid ground. Even down to the Trojan war, and possibly far beyond it, the poetical legend and the prosaic fact hinge one upon the other. It will, however, occupy too much of our time to dwell upon these matters, and be more to our purpose to take up the thread of Grecian history from the time of the planting of fresh colonies in Africa, on the coasts of Sicily, and on the southern part of the Italian frontier. The Greeks, so far as we know, were the pioneers of mankind in the great work of colonisation, and this disposition to colonise is a most distinguishing characteristic of a people. It is an evidence of faith, fearlessness, vigour, and enterprise; and surely that nation which first showed these mighty gifts to other branches of the human family deserved well of their race.

The early history of Greece centres itself about two of her States, Athens and Sparta, and the chaplet of glory hung for many years at equal distance above the head of each of these communities. The physical contour of the land seemed to necessitate the formation of a multitude of States, and human nature would insist that in the course of events one or more of these should over-ride the others. The Spartans, having conquered Laconia, kept their ascendency over their subjects, though seriously outnumbered by them, through their superior energy and stern habits of life. They lived subject to wise laws and sound institutions, which were revived for them by their sage, Lycurgus. They were ruled by two kings, who held between them the power of the priesthood and the command of the army; but the real government of the State was in the hands of the Senate and Assembly. A certain section of trade and manufacture was carried on by the Lacedæmonian Periœcians, who, though belonging to the conquered race, retained a share of their freedom; the rest of the original inhabitants were reduced to slavery, and called Helots.

To Athens, however, belongs the larger share of glory, as the history of the nation runs on. Wise laws, consolidated political strength, honoured Councils, the concentrated powers of the Areopagus, or Court of Mars' Hill, before which the great Apostle of the Gentiles pleaded the cause of

Christ—all these she had. But Athens, like many another State, won her fairest laurels in fierce fight. And so long as history lasts, the victory on the plains of Marathon will be told and retold with ever-increasing interest. A few words must suffice for it here. A mighty Eastern king, Darius Hystaspes by name, invaded Scythia, but its wandering tribes kept out of his reach, and he was obliged to hasten back to the Danube for food. The Scythians, eager to cut off his retreat, urged the Asiatic Greeks to break up the bridge of boats by which he came, and recover their freedom. Miltiades, the then tyrant of the Chersonese, who had been assisting Darius against the Scythians, but now deserted his cause, had, it is said, urged the adoption of this plan, but it found few advocates. Darius crossed over in safety, but he did not forget the daring counsel, nor the daring counsellor who ventured to urge the destruction of the bridge. Some years were spent in nurturing and maturing a revenge which should place not only the colonists of Chersonesus, but Athens herself at his feet. So, with a mighty force, some 2,360 years ago, the Persians, 100,000 strong, landed upon the plains of Marathon to subjugate the rising Queen of Grecian States. Against this host Athens could only bring 9,000 men. Good, true, well-armed, well-disciplined, indeed, but the odds against them were fearfully great. At the last moment 1,000 Plateans appeared before the Athenian camp, and asked to share with their sister State the issue of the coming fight. This, however, left the terms of meeting hard for the side of the Greeks, since even now the difference stood ten to one against them. Moreover, the Persians were men of war from their youth. They had the prestige of a hundred successful battles to bear them on. The Median, Lydian, Babylonian, and Egyptian empires had all fallen before the shock of these renowned warriors. Greek cities also, many of them as populous and powerful as Athens itself, had been taught by a bitter lesson how vain it was to offer resistance to these invincible foes. Greek and Persian had met before, but the battle was always for the Persian. How, then, should Athens look steadily at the dark mass of conquering foes which were drawn up on her sacred soil, or measure herself against a foeman gifted with ten times her strength? Happily for Greece, happily for the world, happily for freedom, the brave polemarch, Callimachus, at the urgent entreaty of Miltiades, gave his casting vote to fight; of the ten generals five were for battle, five for negotiation or delay; but their commander-in-chief, like a brave and wise man, committed them to the result of placing Athens the foremost among the cities of Greece, and among the cities of the world, or of losing everything dear to them as men, and sacred to them as a nation, on this field. All through a long September day the tide of battle rolled. Callimachus had the right wing of the Athenian army, the Plateans formed the left; Themistocles and Aristides commanded the centre. Dashing forwards at the double the Athenians charged right on the Persian forces before they had time to form line. Their old military formation, the phalanx, enabled them to maintain an unbroken front to the enemy who manfully opposed them, without a chance of breaking through. The Athenian centre was thrown into confusion and hurled back, but Miltiades closed his wing upon the advancing Persians, whose line gave way, and never again could they reunite their strength. The rays of the setting sun gleamed full athwart their faces, adding to the discomfiture and confusion of the scene, and, as he sank below the horizon, the glory of the Persian arms had passed away for ever; for never since has the Eastern soldier met his European adversary upon equal terms, where the issue has been for a moment doubtful.

The Persians were driven from the field, and made for their ships; the Greeks following them down to the water's edge. 'Bring fire! bring fire!' was their cry as they strove to lay hold of the galleys and detain them till the work of destruction was completed. But desperation gave strength to the retreating host, and the chase to the water-side proved more disastrous to the Greeks than the hard knocks on the field. Now fell the brave war-ruler Callimachus, the general Stesilaus, and many other Athenians of note, but the day was won; 6,400 Persians lay lifeless upon the ground, and the might of King Darius was broken for ever. Ten years afterwards the galleys of Xerxes, the successor of Darius, once more danced upon the waves of a Grecian sea, but at Salamis a still more signal victory awaited the Athenian navy than that which her army had won on the plains of Marathon; and Athens, after shaking herself free of an enemy many times her superior in strength, was left to forge out her destiny, and rise to her pre-eminence as the foremost State of Greece. It would be ungenerous to pass by without a word the memorable deeds of Sparta wrought in this interval. In the same year as the battle of Salamis, a small force of 300 Greek patriots under Leonidas, the Spartan king, held the pass of Thermopylæ against many thousands of the Persian foe. Long and bloody was the struggle, till a traitor, whose name must be for ever a byword and reproach, guided a detachment of the enemy by a mountain path to the rear of the Spartan troops. Leonidas, seeing that all was lost, dismissed nearly 4,000 of the Grecian allies who had joined him against the Persians, and with his 300 fellow-citizens and 700 brave Thespians, who would not leave the handful to perish alone, fought till every man was slain, and the laws of the State, which forbade retreat, had been manfully vindicated.

The history of Greece now enters upon a new phase, which it is impossible here to follow. Mutual jealousies between Athens and Sparta hindered and restrained the power of each. Athens gradually rose to the position which was hers naturally, and developed that wonderful intellectual energy which, no less than her military prowess, makes her the wonder of earth. A literature such as no other people has ever approached in pathos and sublimity, sculpture which to-day forms the unassailed models of all that is graceful, truthful, and chaste; architecture which all the world has copied—but only copied, and which will never be surpassed—philosophy, rhetoric, science, statesmanship; Socrates, Pericles, Demosthenes, Sophocles, Phidias, a crowd of illustrious names—all these were hers; nor was Athens sole mistress of the universe of letters and thought. Other States of Greece furnished their quota to fill up the measure. of the national glory. Thebes, Corinth, Achæa, scarcely came behind her in intellectual wealth and mental dowry, and every State, almost every town in the land, had her wise and valorous citizens. Greece, from the time of her Persian victories, was the home of the beautiful, the artistic, the noble, the true; but, like other great nations, her hour of decline came. Alexander the Great extended her influence over the East; the greater part of Asia west of the Indus belonged to his sovereignty, but at his death Greece became rather the Muse of other nations than the mistress of her own destinies. Another great power was rising in the midst of the earth, destined to have a still more mighty sway; and from the conquest of Macedonia by the Romans in B.C. 197, the history of Greece is merged in that of her more powerful rival for fame. She was overrun by the Goths A.D. 267, and again A.D. 398 under Alaric; and, after being occupied by the Crusaders and Venetians, at length fell into the power of the Turks on the conquest of Constantinople. Of her after-history there is much to tell, but it is the history of her dissolution. Generous minds and warm hearts—not less than political sagacity and wise counsel—have essayed in recent times to raise her from her degradation and make her once more a power in the world. Over this fair land humanity has written the word Ichabod, and the glory is departed, apparently never more to return.

W. P.

GREECE.

ec′-sta-sy (Gr. ek, stasis), *excessive joy, rapture*
her-o′-ic (Gr. heros), *pertaining to a hero*
vis′-ion (L. visum), *a phantom*
e-ter′-ni-ty (L. æternus), *duration without end*
ab-sorb′ (L. ab, sorbeo), *to suck up*
zen′-ith (Ar.), *the point overhead opposite the nadir*
na′-dir (Ar.), *the point in the lower hemisphere opposite the zenith*

HAIL, lingering rays of glory's sun,
With weird and awful beam,
Land of the sculptor's ecstasy,
Land of the poet's dream!
What heart that ever throbbed in man,
For the beautiful and free,
Unmoved can turn, heroic land,
His yearning soul to thee!

What visions of the mighty past
  Stalk round us at thy name,
With the rustle of the myrtle leaves,
  And the trumpet peal of fame,
And the calm and lofty foreheads
  Of heaven-gifted men,
And the laurel branch upon the sword,
  The bay upon the pen!

So, we hear thy rivers murmur,
  In the dreamings of the brain,
As never streams on all the earth
  Shall murmur e'er again;
For the ripple of Ilissus gleams,
  And flashes into rhyme,
And shall do till Eternity
  Absorb the stream of Time!

Oh, hadst thou, like Leonidas,
  With gore upon thy glaive,
Set at thy high midday like him—
  Gone deathless to the grave;
But, Greece, high name of rapture,
  Let us think, but never tell,
How thy star, from glory's zenith,
  To the deadly nadir fell!

We're proud of thee, we weep for thee,
  Thou art the rose's bloom,
That glows in mournful majesty
  On ancient Europe's tomb.
Hail, lingering rays of glory's sun,
  With weird and awful beam,
Land of the sculptor's ecstasy,
  Land of the poet's dream!

W. S. R.

ROME.—Lesson I.

an-tiq′-ui-ty (L. antiquus), *old times*
my-thol′-o-gy (Gr. muthos), *a system of fables*
mi-rac′-u-lous-ly (L. miror), *in a supernatural manner*
sanc′-tu-ar-y (L. sanctus), *an asylum, a shelter, a holy place*
mal-e-fact′-or (L. malus, factum), *a criminal, an offender*
pre-con-cert′-ed (L. præ, con, certo), *previously concerted or settled*
trans-act′-ed (L. trans, actum), *done*
ma-jor′-i-ty (L. major), *the greater number*
lu′-cra-tive (L. lucrum), *gainful, profitable*
priv′-i-lege (L. privus, lex), *a peculiar right or advantage*
sub′-ter-fuge (L. subter, fugio), *an artifice, an evasion*
pa-tri′-cian (Gr. pater), *noble, senatorial*

Like that of the other nations of antiquity, the early history of Rome defies the research of the student who attempts to separate a wild and poetical mythology from history proper. The city of Rome is recorded to have been founded by twin brothers, Romulus and Remus, who, in their youth, had been exposed on the banks of the river Tiber and miraculously suckled by a she-wolf. The foundation of the city took place in the year 748 before Christ. The original houses were mere huts, and even the so-called palace of Romulus himself was built of reeds and thatched with straw. The free and daring character of the earlier inhabitants attracted to infant Rome the wild and restless spirits who could ill support the restraints of more civilised life, in the older and more firmly-established nations around. In this way early Rome was taken advantage of as a sanctuary for malefactors, outlaws, freebooters, runaway slaves, and other culprits of a fainter or a darker dye, and thus the population of the new city was materially increased.

In the popular choice of a king the election fell upon Romulus, the founder of the city. By the citizens he was accordingly acknowledged as chief of their religion, sovereign magistrate of Rome, and general of the army. Besides a guard to attend his person, he was preceded wherever he went by twelve men armed with axes tied up in a bundle of rods, or *fasces*, the axes to symbolise the executive power of the law, and the rods to signify the strength which lies in unity. The entire power of the king, however, consisted in convening the Senate, assembling the people, leading the army, and appointing the *quæstors*, or treasurers of the public money. The Senate was composed of one hundred of the principal citizens of Rome, who acted as counsellors to the king. All the principal business of the State was transacted in the Senate, the king himself presiding, although every question was determined by a majority of voices.

In course of time two distinct classes were found to have originated in Rome, the patricians and the plebeians. The patricians, or nobility, were the descendants of the earlier senators, and held all the more lucrative and important offices, religious and political as well as civil and military. The plebeians were the common people, who could point to no illustrious ancestry. They had the privilege of objecting to, or of sanctioning those laws which were passed by the king and Senate. By their votes all matters relating to peace or war, the election of magistrates, and even the choosing of a king, were determined. By them all enterprises against the enemy were proposed, the Senate possessing only a negative voice. Each plebeian had the right to elect from the patrician order a protector to assist him with his life and fortune, plead for him before the judge, and attend to his interests generally. On the other hand, the client attached himself to the interests of his patron; he assisted him, if poor, in raising marriage portions for his daughters, and in paying his debts, or his ransom if he were taken prisoner. The client was also bound to serve his patron in war, and to support him with his vote when candidate for any office. He was, moreover, excused from giving evidence in a court of justice if that evidence were likely to conflict with the interests of his patron.

From what has been already said as to the origin of the populace of ancient Rome, it will readily be seen that the number of the male population must have greatly preponderated over that of the female. To obviate this difficulty a subterfuge was resorted to by Romulus and the Senate. A feast was proclaimed in honour of Neptune, and the Sabines, a warlike neighbouring tribe, came, as had been expected, bringing with them their wives and daughters to witness the games which followed the feast. At a preconcerted signal the men of Rome drew their swords and rushed in upon the unsuspecting Sabines, and carried each off by force the youngest and most beautiful woman he could lay hold upon. The women protested bitterly and with tears, but before very long they became attached to their captors, as the husbands of their choice, and refused to return to their own kindred, the Sabines. Such was the origin of that nation which future centuries developed into mighty Rome, the conqueror and the mistress of the world.

W. S. R.

ROME.—Lesson II.

di-late' (L. di, latus), *to extend, to spread out*
ver'-sa-tile (L. versum), *changeable, variable*
al-ter-na'-tion (L. alter), *succession by turns, change*
in-sig-nif'-i-cance (L. in, signum), *unimportance, want of effect*
in-dom'-it-a-ble (L. in, domo), *untamable*
an-ni'-hi-la-ted (L. ad, nihil), *destroyed, reduced to nothing*
ar'-bi-tra-tor (L. arbiter), *a judge*
in-vin'-ci-ble (L. in, vinco), *unconquerable*
rec-og-ni'-tion (L. re, con, nosco), *acknowledgment, formal avowal*
he-red'-i-tar-y (L. hæres), *descending by inheritance*
de-cem'-vi-rate (L. decem, viri), *government by ten men*
an-tag'-o-nist-ic (Gr. anti, agon), *contending against*

Several years ago I remember to have read in the morning papers a notice that the workmen employed in clearing away some houses in the city of London had come upon a very beautiful and perfect specimen of a Roman tesselated pavement, and the account went on to say that the contractors who had undertaken this work of removal had very generously arranged that the public should be admitted to inspect this rare piece of mosaic which had lain buried for so many centuries.

This long-buried treasure seems to connect the London of the nineteenth century with that London which lies beneath flag-stones, and soil, and gravel, over which the Romans lorded it, and ruled in all the pride of high and conquering power. The mind wanders back to that age when the foreign occupier dwelt in his stately villa upon the margin of the stream from which 'The Wallbrook' is said to take its name, and we can easily imagine this ancient city of ours as the arena where keen and versatile men of commerce won their wealth, and where dignified, proud, and stately matrons graced the civic feasts which were hospitably given long before the elements which go to make an Englishman had been evolved from the great womb of the races. But we must not stop even here. Farther and farther back into the past we should most assuredly travel, and not rest till we recalled to ourselves some of the characteristics of that great nation which, springing from a little town upon the Tiber, gradually spread itself out till it reached and conquered every part of the then known world. There is scarce another people whose history is so important or so eventful as the history of this race. There probably never will be a people upon the face of this earth whose history can possibly be more instructive. Every nation and tongue, every community, every form of government, every judicial, military, and political constitution which may hereafter be formed will have something to learn of the Romans. For their record is, humanly speaking, the greatest record the world has to show, and is marked by every alternation between the extremes of most absolute and universal power, and most abject and passionless insignificance. It would be hopeless to attempt anything like a connected history of this nation within the limits of this lesson; it is almost hopeless to try to show any of the main features of the Roman character. I shall be satisfied to give a brief and fragmentary notice of some of their deeds, of some instances of their indomitable valour and perseverance, and leave it to my readers to gather this history for themselves, just adding this remark: That no person—man, woman, boy, girl—must ever lay claim to the title of 'educated' unless some share of this knowledge has been acquired by them.

The Romans were a mighty nation: they retained their great influence and power through many chequered ages of success and defeat, and they became the great arbitrators of mankind, through the possession of several great national instincts—invincible courage, stern morality, and a thorough recognition of the necessities and advantages of laws. Other nations may have been as brave, some nations too may have shared that spirit of inflexible morality which marked the Romans of the better and nobler age, but these people, before and above others, had the wisdom to frame laws, and the moral force to obey those laws which they laid down.

It is said of the immortal ones who fell at Thermopylæ, that they died in obedience to the laws of Sparta, but again and again did the Roman, whether soldier or citizen, patrician or plebeian, prætor or lictor, consul or slave, suffer, relinquish, fight, die, out of a sacred regard to his country's laws. Surely it is a nobler thing to live by laws than to die by laws; it was this living by laws of his own construction which made the Roman master of the world.

Now very briefly as to some points in their history. The Romans, as you have read in the previous lesson, were a mixed people, gathered probably from the Etruscan, Sabinian, and Latin races. Their early history is a collection of more or less probable legends. The city from which they sprang into vigour and importance, is said to have been founded by one Romulus about 753 B.C.; there is, however, little or no reliance to be placed on this matter. The first dwellers in the city of Romulus are said to have been outlaws, slaves, refugees of any and every kind. They were governed by kings for some 250 years, till the oppression of Tarquinius Superbus drove the people to expel him from his hereditary possessions. There grew up under the Tarquins two distinct orders, the patrician or aristocratic and the plebeian or middle class. After the expulsion of the Tarquins the patrician body governed Rome first by a tribunate, then by a decemvirate, then by a military tribunate. It was during the early part of the patrician rule that the military exploits of Horatius Cocles and his valorous companions took place. By degrees the two orders of patricians and plebs became cemented into one strong body, and as this great union developed itself Rome gradually became the conqueror of Italy. Three great wars, the bloody precursors of still more fatal encounters, placed Rome foremost in the rank of Italian communities, and when her right to a foremost place among the nations was challenged by the great warrior Pyrrhus, he found it impossible to curb the rising spirit of the great republic. Then followed her wars with Carthage, bloody, relentless, and fierce, lasting over a period of forty years—wars in which army after army was annihilated, general after general defeated, till finally the great Carthaginian leader Hannibal threatened the sacred city herself, but her people never faltered, and in spite of adverse fate they at last hurled the invader from her soil. Then followed wars with Macedon and Greece, and the destruction of Carthage, till finally Rome had no enemy to meet, for all the world acknowledged her supremacy. With the time of her supremacy, however, came the beginning of her decline, civil discords, mutual jealousies, internal strifes, the break-up of the republic, the triumvirate of Cæsar, Pompey, and Crassus, the re-construction of imperial rule under Augustus, from whose reign the history of Rome is no longer the history of a nation, but a history of individual emperors—many of them great and noble men, well worthy of shaping the destinies of the mistress of the earth; many of them brutal, coarse, red-handed tyrants, who crushed out the national life and weakened and enervated the national spirit, till the mission of the once great commonwealth was finished, and her place among the nations of the earth lost. Then came the end, long delayed, long unrecognised, long struggled against, but nevertheless the end, when her people should be no more a people, and her name the high-sounding title of that which once had been, but should be again no more for ever.

There is many and many a noble episode in her history, full of wonderful lessons for all time, and it is difficult to make a selection of any particular event where the annals are so full of glorious record, but this one instance of Roman valour I am about to relate has always seemed to me to represent most faithfully the stern determination of the Roman character, and with it I shall conclude what I have now to say on this subject.

During the earlier part of the Punic Wars, when the Carthaginian leader Hannibal had routed army after army sent against him by the republic, when he had overrun a great part of Italy, sacked towns, levelled fortifications, put to death prisoners taken in battle, had exacted fearful reprisals from each antagonistic State, and had sent home to Carthage more than a bushel of gold rings which had been taken from his foes killed in fair fight, and at length had planted his standard within sight of the walls of the Imperial city, though the consternation was great—for the hours of the republic seemed numbered, since the gods themselves seemed leagued against the nation—the people of Rome did not lose heart in their cause, in their leaders, nor in themselves: they held a public auction and put up for sale that very piece of land upon which Hannibal was then encamped. So resolute was that spirit of theirs, which defeat could not daunt, nor failure quell, that men were ready to give the full value for every acre of land then occupied by the foe. They did not misjudge the issue, for Fortune, which had so long declared against them, through their own loyal courage was once more won to their side. Hannibal saw only the outside walls of the fair city, and then had to retire from the spot with the dismal presage upon his heart that neither his skill, nor his bravery, nor his success, would be of any avail in the end, but that he must go as he came, and leave Rome the undisturbed, unchallengeable Mistress of the World.

W. P.

THE ABYSS OF THE FORUM.

mag-nif'-i-cent (L. magnus, fio,) *grand, splendid*
au'-gur (L.), *one who predicts by omens, a soothsayer*
a-byss' (Gr. a, bussos), *a fathomless depth, a gulf*
or'-a-cle (L. oro), *something delivered by supernatural wisdom*
vo'-tive (L. votum), *given by vow*
chasm (Gr. chasma), *a cleft, a gap*

'In 362 a deep and fathomless gulf opened in the Forum, nor could it be filled up again. The diviners declared that it would never close until what was most precious in Rome had been thrown into it. As all were disputing what that could be, a noble youth, M. Curtius, reproached them that they did not know what was the chief treasure of Rome; then seated on his war-horse, in magnificent armour, he called upon the gods, and leapt into the yawning gulf, which instantly closed up.'

HORRID and deep the chasm yawned,
  And men with bated breath
Looked, trembling in their triple mail,
  Adown that gorge of death:
That gulf, rent by the hand of Heaven,
  With terror and amaze
Struck all the hoary augurs dumb,
  And seers of ancient days.

'Hear! we invoke thee, God of gods,
Upon Olympus' brow;
Why hast thou caused Avernus' jaws
To yawn upon us now?
Oh close that horrid rift of death—
In battle raging high,
Dashing through blood, with sword in hand,
Let us like Romans die!

'But let us not be swallowed up
By Lethé's solemn wave,
Till heart and sword have won for us
A name beyond the grave;
May our tomb be wide and bloody,
But not a grim abyss,
A gaping of the Infernal World,
An earthquake rent like this!'

Diviners seek the Oracle,
To read this thing of fear,
And many an augur lifts his staff,
Bows many a hoary seer:—
'Hear us, O Oracle of Fate,
Beneath this awful dome!'
''Twill close—Throw in that earthquake's rent
THE NOBLEST THING IN ROME!'

So spake the Oracle of God.
'What is the Noblest Thing
Into this gloomy Bottomless
With votive hand to fling?'
They gave the splendours of the mine,
The wealth of sea and shore;
Still, fathomless and terrible,
The chasm yawned for more

'Rome's Noblest Thing,' said Curtius,
'Is her hero heart and hand,
The might and manhood of her sons,
The soldier and his brand.
Stand back, my lieges all,' he cried;
'For altar, hearth, and home,
I'll do a deed, so God me speed,
For glory and for Rome!'

Upon his stirrups, proud he rose,
And waved his sword on high,
Then took his glance of last farewell
Of man, and earth and sky,
Then spurred into the awful gulf,
For altar, hearth, and home,
And the dread chasm yawned no more,
In thee, O mighty Rome!

W. S. R.

NORTH AMERICAN INDIANS.

ad-ven'-tu-rous (L. ad, ventum), *bold, daring*
in-hab'-it-ed (L. in, habito), *dwelt or lived in*
civ-i-li-sa'-tion (L. civis), *the act of civilising*
im-mor-tal'-i-ty (L. in, mors), *exemption from death*
in-ces'-sant-ly (L. in, cessum), *without intermission*
ar'-ti-fice (L. ars), *a trick, fraud*
vin-dict'-ive (L. vindex), *revengeful*
tra-di'-tion (L. trans, do), *oral account handed down from age to age*

At the time when North America was discovered by Columbus, the whole of it was peopled by various tribes who were called by the adventurous voyagers '*Indians*,' from the belief that the continent they had found formed part of India; they expected to reach the latter country by sailing westward, having no idea of the existence of the vast undiscovered continent which lay in their way. When they landed, therefore, they concluded they had reached some part of India, and the name which they then gave to the natives, though erroneous, has clung to them ever since.

The whole of the northern continent at that time was inhabited by various races, differing in many points, but who from their copper-coloured skins have been called 'red men,' or 'red Indians.' These were divided into numerous tribes, each of which possessed a certain tract of country in which they ruled, and through this vast wilderness they roamed, knowing nothing of the arts of civilisation, subsisting entirely by the capture of wild animals, and living in rude huts or wigwams, or tents covered with skins. In person they were tall and finely formed, with all their senses trained by constant exercise to the highest pitch. They possessed many great moral qualities. They were brave and skilful in war, would bear any pain without flinching, were humane, truthful, and honest. They had no trace of idolatry, but all worshipped a Supreme Being whom they called the Great Spirit, and they believed in an existence after death, but they had no higher idea of immortality than this, that their time would be spent in the happy hunting grounds, where without drawback they would enjoy all the pleasures of the chase. In habits they were temperate, never indulging in those fits of disgusting gluttony practised by many savages. Their clothing was made of the skins of animals, which they tanned and prepared with great skill, and ornamented tastefully.

To their friends they showed great kindness and care, but, on the other hand, their character was marked by many of the hateful qualities which savage man exhibits. Each tribe was incessantly engaged in war with one or other of their neighbours, and in its prosecution every artifice and treachery were practised. In the treatment of their enemies they were cruel, bloodthirsty, and vindictive. All the men shaved the head with the exception of a lock which was allowed to remain on the back of the scalp. Every warrior when he killed an enemy stripped this portion of the scalp with the lock of hair from the head of his victim, and he who could carry the greatest number of scalp locks at his girdle was considered the first warrior of his tribe. There were no laws by which the tribes were governed, but each individual was expected to redress his own wrongs, and the accomplishment of this was considered so important by the tribe, that the warrior who failed to wreak his cruel vengeance on his foe was scouted from his tribe with contempt.

The settlement of the white man on their shores brought, alas! many evils to these children of the forest. They were gradually dispossessed of their hunting grounds, but worse than this was the introduction amongst them of rum. Drunkenness, poverty, and disease followed, and from these combined causes, with the addition of firearms, they have gradually diminished, until of the eight or ten millions estimated in Columbus's time, scarcely two millions exist at the present day, and their extinction is slowly approaching. The principal tribes are the *Choctaws*, the *Mandans*, the *Blackfeet*, the *Sioux*, the *Pawnees*, the *Crows*, the *Apaches*, the *Ojibbeways*, the *Osages*, the *Comanches*, the *Shoshones*, the *Flatheads*, the *Araphaoes*, and some others. These vary in language, dress, dwellings, &c., though there is a general similarity. Their arms were a lance, bow and arrows, and a tomahawk or small hatchet, but now the remnants of the tribes all possess firearms.

The chief of a tribe generally wears a shirt and leggings of deer skin, prepared so as to be perfectly soft and pliable. The seams are sewn with thread of deer's sinews, and ornamented with small quills of the porcupine. Over this is worn a robe of buffalo hide with the hair inwards, and outside is usually painted the battles in which the wearer had distinguished himself. His shirt and leggings are fringed with scalp locks, and when he goes to war, he paints his face, so as to present the most imposing appearance to his enemies. His head-dress is made of the skins of ermines, ornamented with eagle's feathers, and a shield of wood, covered with hide, completes his equipment. Deer skins form the dress of the females, and these are often beautifully and elaborately embroidered.

The tribes inhabiting the prairies, or level plains frequented by vast herds of buffaloes, live on the flesh of those animals, which they also cut into strips and dry for winter consumption. The men consider it their duty to fight, and to procure food for their families; but their wives, or squaws, do all the work about the camp, and their life is one of much privation and hardship.

The Sioux live in wigwams formed of long poles covered with skins sewn together. The Pawnees construct theirs of prairie grass, much in the form of our straw beehives. The Mandans make their wigwams of a circle of timber. Having excavated a hole, they place beams and boughs across, covered with earth, in a dome-like form. Whatever the structure of their dwellings, a hole is always left in the top for the smoke to escape from the fire, which is placed in the centre.

In every tribe are certain doctors, or *medicine* *men*, who dress in the most frightful manner, so as to impress their patients and the tribe generally with their mysterious power, and they are looked upon with great awe as able to do anything marvellous, such as to bring rain, or to cause it to stop, imposing by mere trickery on their deluded followers.

Some of the tribes—such as the Comanches, the Pawnees, and the Apaches—possess great numbers of horses, which they capture by means of the lasso from the immense droves which run wild on the prairies. They are skilful riders, and fierce warriors, and their constant attacks on white settlers in the Far West have made it necessary for the United States Government to send a large body of troops to repel them. The Pawnees look very fierce in their war dress, for they shave their heads and paint them with vermilion, adding a crest of horsehair and a deer's tail dyed red.

Some of the tribes have a curious tradition of the Deluge, believing that all the human race was drowned with the exception of one man, who landed on a mountain from his canoe.

W. J. S.

SIEGE OPERATIONS.

cir'-cum-stan-ces (L. circum, sto), *state of affairs*
be-sieg'er (be, siege), *one who besieges or hems in a place*
for-ti-fi-ca'-tion (L. fortis, fio), *a place built for strength*
ar-til'-ler-y (Fr. artillerie), *massive weapons of war, cannon*
pre-ci'-sion (L. præ, cæsum), *accuracy*
pen'-e-tra-tive (L. penetro), *piercing*
ca-pit'-u-la-ted (L. caput), *surrendered on conditions*
gar'-ri-son (Fr. garnison), *soldiers for the defence of a town or fort*
pro-por'-tion-al-ly (L. pro, portio), *in due proportion*
par'-a-pet (L. per, pectus), *a wall or rampart breast high*
as-sail-ant (L. ad, salio), *one who attacks*
im-pu'-ni-ty (L. in, punio), *exemption from punishment*
es-ca-lade', (L. scala), *the act of scaling the walls of a fortification*
con-struct'-ed (L. con, structum), *built, made*

Until the close of the fourteenth century stout walls of masonry were deemed capable, under favourable circumstances, of resisting any weapons of attack which could be brought against them. This was the period when castles flourished. But when the invention of gunpowder gave the besiegers the power of battering down from a long and safe distance the very strongest walls, all existing fortifications were doomed. The castles of the Royalists afforded but little protection against the artillery of Cromwell, as the ruins of many a once noble edifice now testify. From that date the art of fortification underwent a complete change. Stone walls gave place to mounds of earth (against which artillery was much less effective), and whenever it was found impossible to avoid having recourse to masonry it was as far as possible concealed from observation.

The extended range of modern ordnance and small arms, and the increased weight, precision, and penetrative power of the missiles, are destined to effect a change in the future construction of military works almost as great as that produced by the introduction of gunpowder.

The principles of fortification are, however, still the same. One of the most essential of these is that every line of works must have a flanking defence—i.e. must have another line running nearly at right angles to it, so that troops advancing to attack either may be taken in front by the defenders of that line and in flank by the defenders of the other line. To illustrate the wisdom of this rule and also the manner in which works are constructed, let us suppose it necessary to fortify a small town.

The first step would be to have lines round the place on which the works should be erected; the next being to dig a ditch, throwing the earth on the inner side to form a mound or rampart which would encircle the entire place. Two excellent defences would thus be obtained—viz., a wide and deep ditch and a high wall of earth. This rampart would not only form an additional obstacle to the enemy, but its summit would afford a high and commanding position for the guns. Another and lower mound would be formed on the outside of the ditch and made to slope off to the level of the country, thus, besides affording a protection to the garrison, forming a smooth level surface up which the enemy must advance before reaching the ditch. A wall of earth would be thrown up on the top of the rampart to protect the guns, openings or embrasures being left in it to permit of the guns being brought to bear on the surrounding country. A rough if not complete fortification would thus be formed, which would be found difficult to capture, if the ditch were, as is usually the case in permanent fortifications, at least 20 feet deep and 60 feet wide, and the rampart 40 feet high and proportionally thick. The line of ramparts would be called the enceinte, the wall of earth for the protection of the guns the parapet, and the smooth slope on the outside of the ditch the glacis. In order, however, to allow of musketry as well as cannon being employed in the defence of the place, steps of earth would be made on the inner sides of the parapet and glacis to enable the garrison to fire over their crests. Such a work would, however, have one great defect. Suppose an assailant to have obtained possession of the ditch by a surprise or an advance in the night, the guns of the garrison could not be brought to bear upon him, for being placed on the inner side of a thick rampart they could not be depressed sufficiently to fire at its foot, nor for the same reason would musketry be of any avail. The enemy would thus be in a position of security, although under the very walls of the place, and could mine and blow up the ramparts with impunity.

To obviate this, from the extremities of each line of rampart a large four-sided work called a bastion would be projected, the sides of which would not only command—that is, be able to fire upon—the ditch, but would be so placed that an enemy advancing to attack any point of the works would be assailed in front by one line and in flank by another, and neither in the ditch nor anywhere within range would a spot be left unprotected. This principle of flanking defence is observed in the construction of all fortifications, whether permanent or field. Ravelins, tenailles, caponniers, a covered way, and other advanced and out-works would be constructed to protect and strengthen the enceinte.

Supposing such a work as we have been planning to be attacked by an enemy, he might attempt to take it by escalade—that is, by getting across the ditch and over the ramparts by means of ladders (a method attended by so much danger that it is seldom attempted), or by the more usual process of a regular siege. By investing or surrounding the place and cutting off the supply of food he could compel the garrison to surrender (as was the case at Metz and Paris during the late war), or if that process were considered too slow he might erect works and endeavour to batter down the ramparts.

In order to accomplish this he would approach as near as the range of the guns of the place would permit, and, choosing a favourable opportunity, would throw up a line of trench parallel to the side of the works to be attacked. The earth thus excavated would form on the inner side a parapet, and the trench would thus become a sheltered road and also a place of refuge in case of attack by the garrison. In this trench or first parallel, batteries would be established. At that distance, however, little effect could be produced against the ramparts, so choosing a dark night the besiegers would approach nearer to the works by means of zig-zag trenches, constructed in that form to prevent the garrison from seeing and firing into them (as they could were the trench made direct); and arriving at a convenient distance another or second parallel would be formed, in which new batteries would be constructed and armed by the guns from the first parallel. From this point zigzags would again be advanced until the foot of the glacis were reached, where a third parallel would be made and new batteries established. By this time the fire of the garrison would be considerably reduced and the works damaged. The crest of the glacis would ultimately be crowned, where, if the besiegers succeeded in establishing batteries, the fall of the place would be certain. From that position it would be easy to breach the ramparts, and, if by that time the garrison had not capitulated, the assailants would cross the ditch, and, forcing themselves through the breach, carry the place by storm.

The operations briefly described above are all attended with considerable danger, especially the later stages, and occupy much time, sometimes months and years. Much depends on the bravery of the garrison and the amount of injury it can inflict on the besiegers' works.

S. G.

THE LESSONS OF A BEECH TWIG.

phi-los'-o-phy (Gr. philos, sophos), *the explanation of the reasons of things, the love of wisdom*
sci-en-tif'-ic (L. scio), *relating to science*
de-vel'-op-ment (Fr. développer), *an unfolding*
her-ba'-ce-ous (L. herba), *belonging to herbs*
ger'-mi-nate (L. germen), *to sprout, to bud*
rep-e-ti'-tion (L. re, peto), *the act of repeating*
com'-plex (con, plexum), *of many parts, not simple*
re'-gis-ter-ed (L. re, gestum), *enrolled, recorded*
fluc'-tu-a-ting (L. fluo), *uncertain, being unsteady*
ap-prox'-i-mate (L. ad, proximus), *to bring or draw near to*
en-er-get'-i-cal-ly (Gr. en, ergon), *forcibly, powerfully, spiritedly*
sub-or-di-na'-tion (L. sub, ordo), *inferiority, subjection*
stag-na'-tion (L. stagnum), *cessation of motion*
va-ri-a-bil'-i-ty (L. varius), *changeableness*

To explain thoroughly the philosophy of common things sometimes requires deep scientific researches. Professor Faraday has proved this in his book called the *Chemistry of a Candle*, and Dr. Mantell has shown the same thing in his *History of a Pebble*. We shall endeavour to follow the example of these distinguished men, and give you a lesson from a beech twig.

Consider the natural history of a beech twig.

Every part of a tree, whether leaf, shoot, branchlet or branch, represents the tree at an earlier period of its life and a certain stage of development through which the entire tree has already passed. For the tree was at the commencement of the first year of its life a leaf, and at its close a green herbaceous shoot, exactly like those shoots or growths with which its stem and branches annually terminate; and as the first leaf is a unit, through the repetition of which the first year's shoot is formed, so also is the first year's shoot itself a unit, but of a higher, more complex character, by simple repetition of which the higher, more complicated growths of the stem and branches are produced, which united together form the entire fabric of the tree itself. The whole tree is therefore represented in each of its parts, and therefore from any portion of it the whole tree may be studied.

The age of a tree may be ascertained by counting the rings of wood visible on the cross section of its stem, each ring of wood representing one year's growth. In the stem of some old trees the impress of centuries of seasons of growth and rest has been thus faithfully recorded in their woody layers. But the seasons leave their mark on the outside as well as the inside of a tree. When in spring the young shoot and its summer leaves unfold from the bud, the bud scales or winter leaves which protected them fall off and leave ring-formed scars or *annuli* at the bottom of the shoot, and thus the place is marked where the growing shoot was in a state of rest. These sets of annuli often continue visible on the bark for many years, and by counting them we can ascertain not only the age of the twig, but also the progress of its growth from year to year. All beech twigs have their yearly growths thus carefully registered on their bark.

All beech twigs, over whose surface the progress of growth is thus traceable for a series of years, show great fluctuations in their growths. The length of stem between the annular scars varies. The more favourable the season the wider the interval between the scars; and when the vegetative life of the shoot is approaching to a state of torpor and inactivity, then the annular scars so closely approximate, that their number has to be counted with an eye-glass.

The leaf, like the leaf scale, when it falls off, leaves a visible scar on the bark, and the number of leaves annually put forth by the twig can thus be estimated by the leaf scars.

The leaves, besides contributing individually to the growth of the twig, each form a bud, and when the new leaf dress is finished and packed away, neatly folded in the bud—Nature's wardrobe—then the old leaf dress is thrown off by the tree.

Some of the buds thus brought to maturity become branches, others for want of sap remain torpid and inactive on the outside of the bark, or sink below the bark itself, and remain for years buried in the stem like a seed in the ground, until the tree is injured by storms, its branches torn from its stem; it is then that the current of sap is diverted to these buried buds, which, energetically pushing their way through wood and bark—although the growth of years—to the surface, grow into powerful branches, thus repairing the injury which the tree has sustained, and continuing successfully its battle for a few more centuries of life against the hostile forces of Nature.

We proceed now to consider what may be learned from a beech twig. 1. That in every social community, there must be a government, a subordination of inferiors to superiors, and of the whole to that central power. Thus leaf scales are subordinate to the leaves which they protect, leaves to the twigs which they produce, twigs to branchlets which they form, and branchlets to the branch itself, where the vital power is centralised. There is an equality of rights but not of natural gifts. The leaf scale and the branch are made of the same general chemical elements—carbon, the elements of water and a few earths taken up from the soil, and it is the same with the prince and the beggar in this respect: both are equal, having desires and feelings resulting from common nature, and therefore the same common rights. The awful equity and majesty of law are based on this principle. But there is an inequality of natural gifts, and therefore there must be government and subordination. No family, school, business, or kingdom can subsist without them.

The government must be energetic, or there is no progress. If there is a stagnation of growth in the leading branch, the side branches suffer. Some families, schools, and even nations progress more rapidly than others. All depends on the vital energy of the government.

All must be industrious and the right man must be in the right place. During life all were at work—leaf scale, leaf, twig, branchlet, and branch, and if any one had failed in its duties the branch itself would have suffered. Suppose the leaf scales to have failed, there could have been no leaves; and if the leaf scales had been idle, no wood would have been formed, and the branch would have advanced no farther in growth than one of these side twigs When boys in school are industrious and do their work well, and when in every department of a business, the men employed do the same thing, both the school and the business flourish.

We learn that labour is honourable and every grade of it to be respected. A bud scale, the lowest type of leaf industry, is apparently insignificant, yet the powerful branch owes all its vegetative grandeur, the safety of its life during its successive stages of rest in winter, to the protection afforded by successive generations of bud scales. Let us learn to treat kindly all below us who are trying to be useful, engaged in humble, honourable toil.

Aim at progress under all circumstances. The variability in the length of the intervals of stem between the annular scars, shows progress under unfavourable as well as favourable seasons. Life is one struggle against difficulties, with intervals of sunshine. We can only surmount difficulties by courage and perseverance, and thus progress despite of them.

Let us never lose confidence in ourselves; keep a brave heart and hope for better days. This is also plainly taught by our beech twig. We have seen how the injury to a tree is repaired by the development of torpid buds. So when great men die, others replace them. A time may yet come in your life-history when you will have a chance and see happier and better days. 'Hope on, hope ever.'

We may learn the value of a combination of labour and talent, and also impressive lessons as to our own frailty. The scales protect, and the leaves, successive generations of them united, form the twigs, branchlets, and branches of a tree which stands for hundreds and sometimes thousands of years. The twigs, branchlets, and branches die and fall off like a scale or leaf. So individuals and nations die, and their memory is forgotten. During the active periods of our life we advance by our labour, civilisation, science, the commonwealth of our nation —the work in which our fathers were engaged before us—like leaves contributing to the growth of a tree; and then our work being done, we are removed by the Supreme Ruler. 'We all do fade as a leaf.'

H. C.

THE NATURE OF MONEY.

mis′-chie-vous (S. mis, Fr. chef), *harmful*
in-con-ve-ni′-ence (L. in, con, venio), *unfitness, disadvantage*
en-du-ra-ble (L. in, durus), *that can be borne*
cal-am′-i-ty (L. calamitas), *misfortune, misery*
an-nu′-i-ties (L. annus), *yearly allowances*
ex-ten′-sion (L. ex, tensum), *a making larger*
de-note′ (L. de, noto), *to mark, to betoken*
suf-fice (L. sub, facio), *to be enough*
per′-ma-nent (L. per, maneo), *durable, lasting*
im-pede′ (L. in, pes), *to hinder*
de-scend′-ant (L. de, scando), *the offspring of an ancestor*
at-tract′-ed (L. ad, tractum), *drawn to, enticed*

It would appear at first sight as if no one could fail to understand the real nature of money. Yet many wrong notions have been held about it, some of which have produced very mischievous effects.

It is sometimes thought, or appears to be so, that money is valuable in itself apart from the things that can be purchased with it. Yet to Robinson Crusoe treasures of silver and gold were of less value than one grain of corn. And no one really strives for money for itself. A man labours that he may get for himself and family food, clothes, a house, books, and other pleasant or necessary things. If with equal completeness and equal convenience he could get these things without money, he would not need it or care for it.

In the early rude ages no money was used. Men bartered what they wished to exchange, but a moment's thought would show what unspeakable confusion would be introduced by such a system in a busy land like ours.

Yet the whole of men's business with each other is *based* on this same exchange or barter. The labourer barters his labour, the author his wisdom or learning, the soldier his bravery, for the different things that help to make life endurable and pleasant.

Everyone in the land, each in his proper calling, is producing, or should be, some useful thing to add to the great common stock from which all are to be nourished and sustained. Each receives from that common stock the share which he is entitled to, and his money or wages are but the tokens which show how great or how small is his proper share. We may imagine this sharing of the results of our united labour to be going on more or less justly every day, and we may notice here one of the many advantages of money. A man may prefer not to receive and consume his proper share at present, but wishes rather to save it for his children or for other purposes. If so, he simply saves instead of spending his wages, and so his object is secured.

It will not be difficult to show how money may change in value. Since the money or wealth a man possesses denotes the share of the common stock of valuables which he is entitled to receive, it might be thought that there is just enough money to purchase this whole stock. There is not, however, nearly so much money in a country, because only a portion of these valuable things can be offered for sale and purchased at any one time. The money of a country just suffices to buy that portion. If, now, there should be a great increase in the common stock of valuable things from any cause, such as good crops, it is plain that a greater amount will be bought for the same money, or, as we say, prices fall.

If it were possible that to-morrow the whole amount of money in the world were reduced to one half, a sovereign would then, of course, be twice as valuable as now, and the immediate effect would of course be great confusion in all bargaining. This, however, would be the permanent result. That which costs 10*l.* now would then cost 5*l.* only, and the world be neither the richer nor poorer, when the ill effects of the surprise were past. Were the wheat stacks reduced to one half it would be a real calamity, for wheat is a real article of wealth, while money is not.

Again, if the amount of money in the world were suddenly doubled, the effect would be that a sovereign would be only half as valuable as now, so that what now costs 1*l.* would then cost 2*l.* A man earning 6*s.* a day would then earn 12*s.*, but would pay double for all the things he purchased, and would, therefore, be no better off than before.

Now, changes of this latter kind have really happened in the history of the world. When America was discovered, so great was the supply of gold brought into Europe that prices of things changed wonderfully, and it is said that 1*s.* before the discovery would buy as much as 1*l.* will now. These alterations in the value of money are, however, undesirable. They confuse and impede trade and in many ways are injurious. If a person lends 1,000*l.*, and is repaid when money has become reduced in value, we see that he is unjustly punished. Those who are receiving Government annuities or fixed salaries also suffer when any alteration in the value of money takes place.

We see, then, that a discovery of a gold mine is not really a gain to the world—not directly, at least. Nay, it is a loss rather. A man goes to the gold-diggings and gains 20,000*l.* Is the world the richer? Has the man added anything to the general stock of things really useful and valuable? He has not, but he has become in a position to possess 20,000*l.* worth of them without having produced any portion.

The world is, then, the poorer by that amount, for he or his descendants will receive and consume that amount of the things which others have produced.

Such discoveries of gold mines are not unmixed evils, however; in several respects they are rather benefits to the world. It is desirable to maintain the value of money unaltered. But money itself gets worn away, though very slowly; is lost in shipwrecks, or even buried in the earth. Fresh stores are constantly needed to balance these losses. Great extensions of trade, too, make a greater quantity of money necessary. Our great and increasing trade with China and India has absorbed a very great deal of the Australian and Californian gold, and has prevented a change in prices, which would otherwise have happened. And the discovery of gold mines has attracted settlers to Australia and California, and so has widened the area on which the energies of mankind may be displayed.

R. McW.

PROPERTY AND CAPITAL. (LESSON I.)

ad'-vo-ca-ted (L. ad, vocatum), *pleaded for, defended, supported*
ma-jor'-i-ty (L. major), *the greater number*
plau'-si-ble (L. plaudo), *apparently right, specious*
fal'-la-cy (L. fallo), *deceitful argument*
con'-sti-tu-ted (L. con, statuo), *made, appointed, established*
sub-or'-di-nate (L. sub, ordo), *inferior in rank or power*
ac-qui-si'-tion (L. ad, quæro), *the act of gaining*
com-pe-ti'-tion (L. con, peto), *rivalry, contest*
de-mon'-strate (L. de, monstro), *to prove certainly*
a-me-li-or-a'-tion (L. melior), *the act of making better*
in'-di-ca-ted (L. in, dico), *showed*

In various ages, as well as in the days in which we live, there have been foolish or mischievous persons who, looking with eyes of envy on those more fortunately placed than themselves, have advocated an equal division of property. They have argued that all men are equal by nature, and that therefore it is contrary to principles of equity for a favoured few to be possessed of wealth, with the comfort and luxuries it commands, while the majority suffer from comparative and many from actual want. These arguments at first sight seem plausible, and they sometimes succeed in catching the thoughtless and unwary, who thus are rendered discontented with their lot, and sometimes indulge in most uncharitable feelings towards their richer neighbours. A little reflection, however, will enable everyone giving his common sense fair play to detect the exceeding fallacy of such arguments. We have but to exercise our observation to see that human beings are variously gifted. Some possess more natural ability than others; some are stronger than others; some are more industrious, temperate, and frugal than others; some seem born to rise, others to fall, or remain in the dead level of their natural state; some seem specially endowed for command, others for service; some exhibit qualities of mind which enable them to overcome difficulties, to rise superior to misfortunes, and thus to break through all opposing forces to the attainment of any object upon which they set their hearts; others, on the contrary, seem to be without ambition or even proper self-respect, and so incapable of making improvement or progress. If we will use our eyes, we may all see instances, and may read of many more, proving that, while man is constituted as he is, it is impossible but that some will excel others, and reap the worldly fruits of their superiority.

It is obvious, therefore, that were it possible for the dreams of these favourers of equal property to be realised to-morrow, the equality they long for would be very short-lived.

Society and government are necessary to man, in his present state. Those, therefore, with superior natural ability would soon rise to positions of rule and office, while those of inferior powers would either willingly—most probably willingly—or of necessity, have to obey and be subordinate. The strong, again, would rise superior to the weak, for even if they exercised their strength in behalf of the weak they would look for and exact some return, either of money or service, for the protection they afford. The temperate, industrious, and frugal too would soon reap the advantages of these qualities by the acquisition of the possessions of the idle, vicious, and self-indulgent, who would be forced to yield them these in the unavoidable competitions of life. We have said enough to make it clear that the equality referred to would necessarily be of very short duration, and that there would consequently soon be a return to the condition of things now prevailing: —there would be great and small, high and low, rich and poor, as now; and nothing could alter this state of things: for one's sense of justice revolts at the monstrous proposal that as soon as this occurred, a re-division should take place—a proposal which means simply this, that the good, the upright, the gifted, the temperate, the frugal, and the honest are to be continually ruined and degraded for the support and encouragement of the dishonourable, the vicious, and the wasteful: a strange proposition to come from those who found their agitation upon principles of equity. Such a conclusion is sufficient to demonstrate the baselessness of their claims and the unsoundness of their arguments.

I will not suppose that any of my readers are shallow enough to be influenced by ideas such as these. Nevertheless it must be admitted that there are great and very sad inequalities in human society, which perplex and dishearten many. The workers and producers fare poorly, while those who do not work seem to reap all the advantage. It seems as if the few benefited at the cost of the many; and some, seeing these things, refer the cause to the possession by the few of wealth while the many are poor. Hence has arisen much ill-feeling, and hence have sprung many evils. Human life has been sacrificed and untold misery caused without any amelioration being secured, and for this reason: the true cause of want and labour has been missed. Nature—that is, the constitution of man and the condition of the earth under God's appointment—compels men to labour. Property, which, as indicated above, cannot but exist, so far from increasing, lightens the evil—so far as there is evil. We must, however, bear in mind that there is no evil in labour. There is evil in want, and property relieves and softens this, as will appear from what follows in the next lesson.

C. H.

PROPERTY AND CAPITAL. (LESSON II.)

mit′-i-ga-ted (L. mitis), *tempered, softened*
min′-is-ter-ed (L. minister), *served*
ef-fec′-tu-al-ly (L. ex, factum), *in an effectual manner*
ab-stain′-ing (L. abs, teneo), *refraining, forbearing*
ma-tu′-ri-ty (L. maturus), *ripeness, completion*
en-hanc′-ed (Fr. en, hausser), *raised, advanced, increased*
ac-cu-mu-la′-tion (L. ad, cumulus), *the act of heaping up or increasing*
ag′-gra-vate (L. ad, gravis), *to make worse, to increase*
u-ni-ver′-sal-ly (L. unus, versum), *throughout the whole*
ad-he′-sion (L. ad, hæreo), *the act or state of sticking to*
sup-pres′-sion (L. sub, pressum), *the act of subduing or restraining*

We concluded our last lesson by promising to show that the evils attendant upon labour and want were not to be referred to the possession by a comparative few of property, but, on the contrary, that property mitigated these evils. We now proceed to fulfil our promise.

Capital, which is the child of property, encourages the arts and industries of civilisation. These flourish by its means, and we can all perceive that the reward of labour would be far less than it is were capital no longer to exist.

It is evident, therefore, that labour partakes of wealth; for while the possessors of riches have their own comforts ministered to, and are supplied with their luxuries through the exertions of labour, they have, in return, to reward labour for its efforts on their behalf. Thus those who labour enjoy the wealth as well as its owners, and they are thus effectually co-partners with them in the realising of its fruits. We must see, then, that capital is as important to the poor as it is to the rich, and that the former are as deeply interested in preserving it from damage or destruction as the latter.

The poor, indeed, may wish to have more of this capital, and no one would grudge them more. It is, however, very much in their own power to obtain, at least, if not a greater share, the highest enjoyment out of the share they now have. Industry, frugality, increased thoughtfulness in their mode of living and laying out what they do possess, the abstaining from spending their money uselessly or injuriously;—the qualities of mind and character promoted by these habits, will not only give them more enjoyment in what they already have, but will also in their very exercise do much towards placing them in a position to acquire more of that capital, in return for their enhanced labour, which thus ministers to their well-being.

It is, therefore, the direct interest of the class receiving wages to do nothing which may prevent or interfere with the security of property; for everything that tends to this has also a tendency to remove the motives to accumulation; because, in order that these may have full play, there must be an assurance of safety and protection for what is thus acquired. It should not be forgotten that it is the wish to save which produces capital, upon which those who labour depend for their living.

There is another consideration of importance connected with this subject. Most of the crimes which are committed are crimes against property. It is true that in very many cases it is poverty that impels to such crimes; but it is not difficult to see that their continued commission aggravates and renders lasting the poverty which all good men would desire to see relieved: for, were property universally respected, it is clear that there would be far less crime than there is; far less expense, therefore, in carrying on the government, and far less revenue needed for that purpose. The capital thus expended in checking and punishing would be available, and would be used, doubtless, to reward the efforts of honest labour.

To prevent such crime is more in the power of the great body of the people than may, at first, appear. It is the usual thought that only legal punishments can restrain crime. These are necessary, but if the general intelligence and conscience were more alive to the truths we are considering, there would be much less disposition to commit crimes against property; and there would be more effectual safeguards against such crimes. The people generally would see the folly and wickedness of these acts and be always on the alert to prevent or detect them; giving their practical adhesion to the truth that those who are thus guilty are the greatest enemies of the poor and the most effectual hindrances to their social improvement.

Let my young readers, then, lay these thoughts to heart. The time has arrived when a determination is evinced that every boy as he grows up shall be taught the elements of knowledge; and the subject of this lesson is one of the most valuable of the departments of knowledge. For to realise right ideas on the subject of property and capital will do much to give you a just estimate of the dignity of labour, and to soften what may be hard or trying in your lot. Being thus enabled, as you grow to maturity, to see how deeply you are interested in the preservation of property, and in the prevention and suppression of crime, you will be taught most effectually how to cure the evils under which you may be labouring, and learn how you may be relieved from the poverty and discomfort which are the result too often of want of forethought or of want of knowledge of the questions treated of in this lesson.

C. H.

WAGES.

sat-is-fac′-tion (L. satis, facio), *that which satisfies*
po-lit′-i-cal (Gr. polis), *relating to public affairs*
e-con′-o-my (Gr. oikos, nomos) *regulation, system*
di-min′-ish-ed (L. di, minor), *lessened*
il-lus-tra′-tion (L. in, lustro), *explanation by example, elucidation*
ne′-ces-sa-ries (L. necesse), *things necessary*
trans-ac′-tion (L. trans, actum), *a thing done*
ac-cu′-mu-la-ted (L. ad, cumulus), *to heap up, to increase*
a-vail′-a-ble (L. valeo), *profitable, useful*
av′-er-age (Fr. ouvrage), *a mean proportion or number*

Most youths look forward to the time when they will go to work and earn wages. This is right:

because all labour is honourable, and there is much satisfaction in knowing that our own hands supply or help to supply our wants. As, however, many mistakes are made by workmen on the subject of wages—arising, no doubt, from their ignorance of one or two of the great principles of political economy—this lesson is intended to give some information on capital and labour.

In every civilised country there must be both workmen and masters. By workmen we mean those persons who are obliged to work to support themselves: their work, of whatever kind it may be, we shall call *labour*. By masters we mean those who give employment to the labourers and pay a certain amount of money for the work done, which money is called *wages*. The fund out of which the master pays the wages is called *capital*. The man who has it is called a *capitalist*; and he uses the capital in the hope of increasing it. The increase made by its use is called *profit*. Thus, then, we have two classes of persons to consider: *labourers* and *capitalists*; and three kinds of things: labour, capital, and profit. Now it often happens that workmen look upon their masters as their enemies rather than their friends. They think that the master wishes to pay as small a wage as possible, in order that he may make more profit for himself; and this arises from the idea that all wages are paid out of profit made in the present time, and hence it is often said by workmen 'large profits for the capitalist mean small wages for the workman; and increased wages for the workman mean diminished profit for the capitalist;' and as the latter is considered the most advantageous for the workman, he seeks to secure that state of things. Now all this is a great mistake, and that it is so will be clearly seen by an illustration.

Suppose a man to be a jeweller, and to be in want of the necessaries of life. Could he but make a pair of ear-rings he could sell them and purchase what he needs. But he has no capital out of which he may buy the gold to make them with, so he has to go in search of some one who has capital and is willing to use a part of it to purchase the material and pay the wages of the labourer. At last a person is found, who, having made a considerable profit on a previous occasion by the same kind of transaction, agrees to lay out one hundred pounds on gold and labour in the hope that he will make a fair profit when the work is completed. He further agrees to use whatever profit he makes in supplying the jeweller with work, so that he may produce more ear-rings.

It is clear, then, that the wages of the jeweller will be paid out of profits which were made in time past and saved, and not out of the profits made by the labour in the present time; and further it is clear that the jeweller's work and wage in the future will depend upon the amount of profit made now and saved. It is the interest, then, of the workman that the master should make a fair amount of profit, and be a careful man, so as to save the profit, and thus increase his capital.

Another point which must not be lost sight of is the fact that sometimes the capitalist makes no profit by the labour which he pays for, but rather loses. Suppose a capitalist to possess one hundred thousand pounds, the accumulated profits of past days. He determines to use the money in mining operations in Cornwall: miners are engaged and wages are paid every week: this goes on month after month, and no return is made, no tin is obtained, and so no profits are realised. At last all the capital is spent, and as none of the workmen have any capital to pay wages out of, the whole affair has to be given up.

Now, it will be seen that if the man had had twice the amount of capital the work could have been carried on twice as long: or if the number of men who needed wages had been fewer by one half, then the same amount of capital would have sufficed for the same lengthened period. On the other hand, if twice the number of workmen had been taken on at the first, the capital would have lasted but one-half the time. You see, then, that the rate of wages will be regulated by the quantity of capital available for the payment of wages, divided by the number of labourers who must subsist out of it. It is clearly, then, to the interest of the labourer that the capitalist should make large profits and store them up, so as to produce a fund out of which to pay wages at some future time.

But the wages of all workmen are not equal: some earn large wages, some small. The engineer, for example, will earn, it may be eight shillings a day; whilst the most skilful ploughman will earn but three shillings a day. If you ask why this is so, you will find the answer in the fact that the number of persons to be paid out of the capital devoted to the former trade is much smaller than those who have to subsist out of the capital employed in the latter. You will understand this clearly by thinking of two division sums, one with a large dividend and a small divisor, and the other with a small dividend and a large divisor. If the dividend represent the amount of capital in the two trades, and the divisor the number of persons who have to subsist on the capital, the quotient will represent the rate of wages of the two sets of workmen.

These considerations should lead young men when they make choice of a trade to enter that which is not likely to be overstocked with labourers.

Again, the rate of wages differs in the same trade. Some carpenters, for instance, earn one or even two shillings a day more than others. The same is the case in other trades also. Now, how is this? A moment's consideration will show us that the one great thought in the mind of the capitalist is the value of the work done for the wages paid. If, therefore, there are two men in his employ, one skilful at his work and another less so, the former will produce more by his labour than the latter, and will receive a higher wage. Such being the case, every youth should seek to be skilful in his trade or profession, and since an intelligent man is generally the most skilful, every one should endeavour to add to his stock of knowledge.

Another point worthy of consideration is the fact that should trade become slack the capitalist will be more ready to keep the skilful man at work than the unskilful—allowing him to use more of his capital in the hope that at some future time he will profit out of the work done, and thereby to increase his capital.

This is a very important matter, and one which should be taken into account by every young man when considering the amount of his wages. The question to be asked is, will the work be continuous? Suppose a man to be paid at the rate of 7*s.* per day, and to be employed but four days a week; his average wage per day will be 4*s.* 8*d.*: while another who is paid 5*s.* 6*d.* per day and is always fully employed will be better off by 5*s.* per week. This consideration, then, should lead all young men before they enter into any trade or profession to take into account the average time per week or year that they will be likely to receive the wages agreed upon, and to choose that which is permanent, even though at first sight it may appear less advantageous.

One other point needs to be noticed, and that is the fact that *character* will always have weight in the choice of the master when appointing his workmen. Skill is good, but skill without soberness, honesty, and an obliging disposition will not stand when there is, as there always must be, a number to select from. Every young man, then, should value a good character, and remember the words of the wise man—'A good name is rather to be chosen than great riches.' J. H.

SAVINGS BANKS.

ba-rom'-e-ter (Gr. baros, metron)	*an instrument for measuring the weight of the atmosphere*
con-tin'-gen-cies (L. con, tango)	*casualties, accidents*
de-pos'-it-ed (L. de, positum)	*lodged in trust*
cen'-tu-ry (L. centum)	*a hundred years*
be-nev'-o-lent (L. bene, volo)	*having goodwill, kind*
com-mu'-ni-ty (L. con, munus)	*the commonwealth*
in-vest'-ed (L. in, vestis)	*placed in possession*
fluc-tu-a'-tion (L. fluo)	*unsteadiness, motion hither and thither*
se-cu'-ri-ties (L. se, cura)	*things given as pledges*
gra-tu' it-ous-ly (L. gratus)	*freely, without charge*

ONE morning last summer, the writer saw a man who was preparing for a long journey. He looked at the barometer : it was falling ; then he glanced at the sky: the clouds were louring. Next he watched the clouds to see from whence the wind was blowing—South-west; then, turning quickly to his daughter, said, 'Polly, dear, fetch me my umbrella and waterproof.' This man was making provision for the future, 'preparing for a rainy day.' Now what that man was doing in regard to the weather, all persons should do in regard to their future bodily wants. In a word, they should remember that the time may come when, either on account of sickness or old age, they will not be able to work ; and that if on provision is made for these contingencies distress and suffering will be the result.

To make provision for future wants, some portion of the earnings of the present time should be put aside, or saved, as it is called. Now, in order to effect a saving, it is necessary that the current expenses be kept below the current receipts; and further, that whatever is the amount of the surplus it should be deposited in some safe place. Such a place is found in what are called Savings Banks.

It was not until the commencement of the present century that the working classes had a proper place of deposit for their spare funds. About the year 1805 it occurred to some benevolent persons that an important benefit would be conferred upon the working classes, if there were institutions of the character of banks, in which the poorer members of the community could deposit the smallest sums they could spare, certain of being able to draw them out when they needed them, with accumulated interest. This led to the establishment of savings banks, first in England, and afterwards in Scotland and Ireland.

At first these banks were carried on by mere private security, but after a time, when millions of money had found their way into them, the Government took the matter up, and an Act of Parliament was passed by which the security of the nation itself was given for the funds deposited. This Act directs that *all* the funds deposited in National Savings Banks must be paid into the Bank of England on account of the Government; and that the money so invested shall bear interest at the rate of 3*l.* 16*s.* 0½*d.* per cent. per annum, whatever may be the fluctuations in the value of the public funds during the time of investment. Depositors are thus afforded the best of all securities—namely, that of the whole British nation; and further, the bank is enabled to give a higher rate of interest than it could do if it were a mere private banker.

The highest interest which the law allows the National Savings Banks to pay is 3*l.* 8*s.* 5½*d.* per cent. per annum, the difference between this and the rate allowed on the money invested by them in Government securities being reserved as a fund for the payment of the officials of the bank and other expenses. The rate usually paid is 3*l.* 6*s.* 8*d.* per cent. per annum. Deposits of from 1*s.* to 30*l.* may be received in the savings bank, but no person may deposit more than 30*l.* in one year, or 150*l.* altogether.

Savings banks have been highly successful. From the date of their establishment to the year 1840, twenty-four millions sterling had been deposited—a vast accumulation of small sums saved out of the earnings of the working classes. A few years ago an Act of Parliament was passed authorising the Postmaster General to establish savings banks in connection with the General Post Office, the Government undertaking to give its own security for the money deposited, and to allow interest at the rate of 2½ per cent. per annum: this is at the rate of 6*d.* in the pound, or one halfpenny in the pound per month. But no interest is allowed on the parts of a month, nor upon the fractions of a pound.

The advantages of the Post-office Savings Banks are very great. They are established in all parts of the kingdom: any sum from *one shilling* to thirty pounds may be deposited in one year: the deposit may be made on any day, and in any place where a bank has been opened: the money may be withdrawn whenever required, and from any Post-office Savings Bank in the United Kingdom: the forms to be filled up for deposit or withdrawal, and the bank-book in which the entries are made, are supplied to the depositor gratuitously: and all letters that pass between the depositor and the Postmaster General respecting money in Post-office Savings Banks pass free of postage.

Then, again, in the case of the death of the depositor without a will, no legal forms or expenses are incurred, the money deposited, if under 50*l.*, being paid over by the Postmaster General to those relatives of the deceased who may be entitled to receive it. Every account opened with the Post-office Savings Bank is considered a private and confidential matter. The Act of Parliament under which these banks were established forbids any post-master or mistress to disclose the name of any depositor or the amount deposited, except to the Postmaster General, or under his directions.

The boys who read this lesson need not stay until they are men to commence saving. Let them put by their odd pence until they have one shilling, then ask their parents' leave to take it to the Post-office Savings Bank. To this shilling may be added others, until a pound is accumulated; then the money invested will begin to bear interest. At the end of the year the interest will be added to the principal. And if this is carried on year after year, a little added to the principal, and of course a little added to the interest, by the time the depositor is a man, a nice little fund will be obtained. And then if, as *a man*, he saves a portion of his wages every year, by the time he arrives at middle age he will possess a sum large enough to supply, or in part supply his bodily wants, when sickness or distress, or the infirmity of age overtakes him. J. H.

FIRE INSURANCE.

in-su'-rance (L. in, securus), *security against loss, by the payment of a certain sum*
des-o-la'-tion (L. de, solus), *destruction, waste*
vol'-un-tar-y (L. volo), *willing*
de-vi'-sed (L. di, visum), *contrived, planned*
re-liev'-ing (L. re, levis), *to lighten pain or sorrow, to succour*
cor-po-ra'-tion (L. corpus), *a society legally authorised to act as a single person*
es'-ti-ma-ted (L. æstimo), *calculation*
prop'-er-ty (L. proprius), *possession, an estate*
mag-nif'-i-cent (L. magnus, fio), *grand, splendid*
ag-ri-cul'-tural (L. ager, cultum), *relating to the art of cultivating the ground*
spec'-u-la-ted (L. specio), *trafficked with a view to gain*
man'-u-script (L. manus, scriptum), *a paper or book written by the hand*

It is one of the most beautiful results of civilisation that we learn more and more to help each other. The golden rule—'Do to others as you would they should do to you,' seems to be working itself out into purely business matters and business rules.

Formerly it was too often the case that, when a trader's premises were burnt, he went out into the wide world a ruined man. Such need never be the case now. Fire is, indeed, such a terrible enemy, brings such swift and utter desolation, that all men are moved to pity, and help those who suffer from it. But *voluntary* help and pity are uncertain things, and a surer plan has been devised for helping such sufferers.

After the great Fire of London, when countless numbers of houses lay in smoking ruins, the citizens began to seek some means of relieving each other in such terrible troubles. Several plans were proposed, and at last the Corporation offered to insure all houses built of wood at the rate of twelve pence in the pound, and houses of brick at sixpence in the pound. But the Corporation tired of the work, and a private company, the 'Friendly Society,' took it up. Their plan was this:—When any house or houses of the Friendly Society were burnt, the amount of damage was estimated, and then divided among the different members in proportion to the amount of property each one had insured. The Society was, therefore, strictly *mutual*, each member being a part-insurer of the other members' property. Indeed, this is in *reality*, though not in *form*, the case in all insurance companies.

From the time of the Friendly Society, 1681, fire insurance grew steadily and rapidly, and has in our time attained most magnificent proportions. In 1865, from October to March, the numerous companies in England insured house and other property to the amount of 627,000,000*l*.. In that year the duty was reduced from 3*s*. to 1*s*. 6*d*. per cent. Since then the duty has been entirely abolished.

And now let us see a little of the plans and rules observed in this fire insurance. First, then, no person may insure property in which he has no interest; that is, property which, if destroyed, would occasion him no loss. Again, what is nearly the same thing repeated, a person may not insure property above its real value. Were these rules not observed, it can easily be seen that insurance might become a species of gambling; and, besides, those who speculated on the possible destruction of the property of others, might be tempted to destroy it themselves. Indeed the second rule is often broken. Men will insure property of a very slight value at an enormous amount, and then commit the terrible crime of arson. This is one of the chief things insurance companies have to guard against.

Then there must be given to the company a very full and detailed description of the property to be insured, of its situation, and especially of the risk of fire it may be exposed to. Any wilful keeping back of such particulars makes the contract of no avail, and the company are not liable for any damage done.

The persons whose property is insured must pay annually to the company a certain fixed amount called the *premium*. The premiums vary according to the nature of the thing insured. Thus bookbinders, because they keep a fire, and have loose paper-cuttings, pay 5*s*. 6*d*. per cent., while booksellers pay only 2*s*. per cent. So a wheelwright, with a stove, pays 10*s*. 6*d*.; one without a stove, 5*s*. A cotton-mill owner has to pay 14*s*. per cent., because cotton will so easily catch fire.

There are some kinds of property, however, which the companies will not insure at any rate. Among such things are money, both coin and bank notes, valuable documents, manuscripts, &c., very costly pictures or statues: and many companies will not insure gunpowder, petroleum, &c. The reason of this can be seen at once. It is either because of the peculiar risk of fire the property is exposed to, or the extremely costly nature of the things insured.

It is hardly possible to over-estimate this blessing of fire insurance. Imagine the heavy load of care which it lifts from the mind of the manufacturer, whose mill may be reduced to ashes in spite of all his efforts. Formerly he would have been a beggar; now he may begin business again, hardly, if any, the poorer.

R. McW.

LIFE ASSURANCE.

as-su'-rance (L. ad, securus), *security*
in-ev'-it-a-ble (L. in, e, vito), *unavoidable*
stip'-u-lated (L. stipulor), *contracted, bargained*
fi'-nal-ly (L. finis), *lastly*
pri'-ma-ry (L. primus), *first, original, chief*
un-im-pair'-ed (S. un, L. in, pejor), *not diminished*
es-tab'-lish-ment (L. sto), *fixed state, settled regulation*
phi-los'-o-pher (Gr. philos, sophos), *one versed in philosophy*
Med-i-ter-ra'-ne-an (L. medius, terra), *encircled with land*
prob-a-bil'-i-ty (L. probo), *appearance of truth*
ex-am-i-na'-tion (L. examen), *the act of searching, enquiring, or questioning*
doc'-u-ment (L. doctum), *written evidence*

LIFE ASSURANCE differs in several points from fire insurance, and in this particular one, that the thing insured against—viz., death—is *inevitable;* while a destructive fire is not. A merchant may for long years pay the fire insurance premiums and receive no return whatever; but the friends of every person whose life is insured receive, sooner or later, the stipulated sum.

Yet this is not so great a difference as it looks. The thing insured against in life assurance is really *early* and *unexpected* death, and only in such cases can we strictly say that the benefit of life assurance has been gained. In other cases, the annual premiums, together with the interest upon them, amount to *more* than the sum which is finally paid.

The primary calculation which has to be made in life assurance is that of the probable duration of human life. Even the old Romans made this calculation more or less perfectly, and valued the life of a man of twenty at twenty-eight years, of a man of thirty at twenty-two years, of one of fifty at nine years, and so on. Human life has been lengthened and made more secure since then; and now the life of a man of thirty is valued at thirty years.

Supposing, then, a person aged thirty insures his life. It is plain that he must pay such annual premiums as will, with their interest, amount in thirty years to the sum for which he is insured. He *may* die far earlier, perhaps the very first year, but other men will certainly live beyond the calculated period, or it would not be a true average period at all.

It is rather curious, but at the same time perfectly certain, that the study of the laws of chance in dicing and other kinds of gambling first led to the establishment of life assurance. A strange instance of good coming out of evil!

The old philosopher who first wrote a work on the subject saw that just as a gambler, if he only played *long enough* with the dice, would certainly regain all which he might have lost, so one might safely insure the lives of a *great number* of persons, resting assured that the long lives would balance the short ones.

There are traces of what resembles life assurance to be found far back in history. A sea captain sailing in the Mediterranean, and fearing capture by the Moorish pirates, would pay a premium to a merchant—who then engaged to ransom him if he were taken prisoner. Pious pilgrims going to the Holy Sepulchre often did the like.

But now we must see the rules observed in life assurance. First, then, no person can insure a life in which he has no interest. That is, there must be no betting or gambling on the probability of any person's death. Then a person before being insured must give in writing a very full and particular account of his health and habits, and must also undergo a medical examination. For it would, of course, be against the interests of the company to insure anyone who will *probably* die early.

In general, therefore, no one can be insured who is not in sound health, and this is one reason why it is wise for *young* men to insure their lives while their health is still unimpaired and unbroken.

The age of the person insuring must be correctly stated, and some proof given—for the amount of annual premium depends upon the age. Thus, to insure 100*l.* at death an annual premium of 1*l.* 17*s.* suffices if the assurance is effected at the age of twenty, but the annual premium is 2*l.* 8*s.* if the assurance is not made till the age of thirty.

The document containing the contract between the company and the person assured is called the *policy*. It may be, and sometimes is, sold by the holder like any other kind of property.

The funds received by the company in premiums are, of course, applied by them in business as advantageously as possible. In many companies a portion of the profits which are made in this way is divided among the persons insured. These portions of profits are termed *bonuses*.

The benefits of life assurance are very great. The strong, loving husband and father is brought to an early grave. All revenue ceases, there are no lands, no property to divide, but the sting of death is partly taken away in knowing that there is one little sum left safe for those whom he leaves helpless behind him.

R. McW.

THE LAW OF GRAVITATION.

grav-i-ta′-tion (L. gravis), *the force by which bodies are attracted to the centre*
im-a-gi-na′-tions (L. imago), *conceptions, images in the mind*
ig′-nor-ance (L. ignorans), *want of knowledge*
ce-les′-tial (L. cœlum), *heavenly*
as-tron′-o-mer (Gr. aster, nomos), *one skilled in the study of the heavenly bodies*
sup-po-si′-tion (L. sub, positum), *position without proof*
per-plex′-i-ty (L. per, plexum), *difficulty, anxiety*
i′-so-la-ted (L. insula), *detached, separate*
con-so-la′-tion (L. con, solar), *comfort*
con-strain′-ing (L. con, stringo), *forcing, compelling*
vor′-ti-ces (L. vortex), *whirlpools*
coun-ter-ac′-tion (L. contra, actum), *opposition*
i-den′-ti-cal (L. idem), *the same*
in′-fi-nite-ly (L. in, finis), *without limits*
per-va′-ded (L. per, vado), *spread through*
en-dow′-ed (L. in, dos), *furnished with a portion, enriched*

The study of the system of the heavens has in all ages been considered one of the noblest, and through the earnest labours of many illustrious men, it has now become one of the furthest advanced of human studies.

The science began, like most others, in strange and fanciful guesses, by which men's imaginations were satisfied and their ignorance hidden from themselves. Many of the ancient philosophers believed the sky to be a revolving crystal sphere, in which the sun, moon, and stars were fixed as beautiful lamps to shed light upon the earth. But observation soon taught them that the sun and the planets were not so fixed, but that *they* changed their position among the other heavenly bodies. Then it was thought there must be some great system of celestial wheels connected with the vast sphere, and revolving within it, each wheel carrying a planet round with it in its rapid course.

These and other such fancies have been swept away before our exacter knowledge; but we must thank the ancient astronomers for the loving patience with which they watched the heavens, and recorded all that they saw that was strange or noteworthy. The old records of the priests in Babylon led the great Frenchman, Laplace, to discover a long hidden law of the moon's motion.

To all the ancient philosophers it seemed an undoubted truth that this our little world was the centre of the universe. A most natural supposition, but one exceedingly unfortunate for the progress of science. For the paths of the planets, when viewed from the earth as centre, seem nothing but perplexity and confusion. It was an immense gain when astronomers learnt to take their station, as it were, in the sun. Then it was found that the planets, the earth among them, describe quite regular paths round the sun as a centre. These paths are very nearly perfect circles. The credit of this discovery belongs to the great German, Kepler. Through long years of poverty and neglect he toiled on, cheered only by the beauty and elevation of the subject itself; and when all his calculations were completed, and his discovery stood in beautiful perfection, even then it gained but little notice. 'God has waited thousands of years for one to discover his plan, and should not I now wait in patience for one to believe my discovery?' This was the brave man's self consolation.

Truth at last prevailed, as it ever must, and all men at last believed the planets moved round the sun; and from henceforth the great study of astronomers was that of central forces, that is, of forces which cause bodies to move round some centre. A very perplexing study it was. For it seemed most natural that a force, or any number of forces, when impressed upon a body would cause it to move in a *straight* line. What then could be constraining the planets into *circular* paths?

Descartes, a great French philosopher, proposed to end the difficulty by supposing that the planets were carried round the sun in whirlpools or vortices, the sun being at the centre. But this was so plainly a return to the random guesses of the ancients that few only believed it.

No satisfactory explanation was found till Newton's time. He discovered that every planet was acted upon by two forces, one of which urged it forward in a straight line, while the other was continually drawing it out of the straight line towards the sun, and by the constant counteraction of these two forces a circular path was described. The former of these two forces was easy to understand. It was considered to be the force with which the Creator hurled forth the planet in the beginning. But the latter? It appeared to arise from the sun, which seemed to possess a power of drawing all things towards it.

Now the question arose, Did such a force exist anywhere else in Nature? or was the sun alone in possession of this mysterious power?

Newton saw that there were forces in Nature resembling this one. The earth seemed to possess a similar power over the moon, and it also has the power of holding all things securely on its surface and of drawing back again anything which might be thrown up from it. After many years of careful study, Newton proved that these forces were not only similar, but absolutely identical. This mysterious power, called FORCE OF GRAVITATION, was not possessed by the sun only, or the earth only, but by every particle of matter in the universe. Every grain of sand, every drop of water, attracts every other material object no less really than the sun does, though with infinitely less power. The earth attracts the sun, and the sun the earth, and they both revolve round the centre of gravity of the two. Were they equal bodies, the centre of gravity would be just midway between them. But, since the sun is so immensely greater than the earth, the common centre of gravity is within the sun's body, and near its centre, so that we may consider the sun as standing still, and the earth only as revolving. It was Newton's glory to see and show that this mighty force pervaded all Nature. Nothing is too distant, too great or too small for its influence. It holds the earth and the other mighty planets in their courses, and maintains their beautiful order, but it also holds the atoms of dust safely to the bosom of the earth, and the drops of water in the ocean bed.

> The very law that moulds a tear,
>   And bids it trickle from its source;
> That law preserves the earth a sphere,
>   And guides the planets in their course.

The mystery of the power Newton did not, and could not, explain; but he showed it was no isolated contrivance which God had made use of in one portion only of His works, but a power with which He has endowed all things, both great and small, from end to end of His creation. 'All Thy works praise Thee, O God!'

R. McW.

COMPOSITION AND PROPERTIES OF THE ATMOSPHERE.

sphere (Gr. sphaira), *a globe, a round body*
in-vis′-i-ble (L. in, visum), *that cannot be seen*
en′-ve-lope (Fr.), *a wrapper, an outer covering*
in-gre′-di-ent (Fr.), *one of the component parts of a mixture*
in-dis-pen′-sa-ble (L. in, di, pendo), *absolutely necessary*
con-sti′-tu-ent (L. con, statuo), *an essential part of anything*
re′-spi-ra-tion (L. re, spiro), *the act of breathing*
com-bus′-tion (L. con, uro, ustum), *the act of burning*
con-fla-gra′-tion (L. con, flagro), *a great fire*
nox′-ious (L. noceo), *injurious, hurtful*
in-ert′ (L. iners), *very slow to act, dull*
ex-pel′ (L. ex, pello), *to throw out*
nar-cot′-ic (Gr. narkotikos), *producing sleep, and in overdoses death*
de-le-te′-ri-ous (L. deleo), *poisonous*
ab-sorb′ (L. ab, sorbeo), *to suck up*
ap-pro′-pri-ate (L. ad, proprius), (v.) *to take for oneself*
a′-que-ous (L. aqua), *watery*
vi-cin′-i-ty (L. vicinus), *neighbourhood*
be-nef′-i-cence (L. bene facio), *the practice of doing good*

The term atmosphere is derived from two Greek words, *atmos*, vapour, and *sphaira*, a sphere ; and is the name given to the invisible envelope of *air* which surrounds our earth, and accompanies it in its revolution through space.

Atmospheric air was long regarded as an *element*, or simple substance; but modern chemists have proved it to be a *mechanical mixture* of several distinct gases. The most important of these are *oxygen* and *nitrogen*, which so exceed the others in *quantity*, that the air is often spoken of as consisting of these two alone, mixed in the proportion of one gallon of oxygen to nearly four gallons of nitrogen. We shall show, however, that there are at least two other ingredients which are *essential* to the composition of the atmosphere.

Undoubtedly the most indispensable constituent of the atmosphere is oxygen, which is the great supporter of respiration and combustion. Indeed, were the air deprived of its oxygen, no human being or animal of any kind would be able to live in it, nor could we get a fire or candle to burn. Moreover, there is no other gas, simple or compound, which could be substituted for oxygen; that is, there is no other gas which alone, or mixed with nitrogen, would form an atmosphere in which animals could live, and fires burn. But it is possible to have 'too much of a good thing,' and an atmosphere composed of oxygen alone would cause animals to live too fast, producing fever, inflammation, and death. It would likewise lead to a general conflagration, for we should not be able to put out a fire, but even the iron fire-grates would burn with a rapidity and fury which would soon set the world in a blaze.

Hence the necessity for mixing the oxygen with a gas like nitrogen, which moderates its action, and renders it fit for animals to breathe continuously without imparting to the atmosphere any noxious qualities. No other gas is so well adapted for this purpose as nitrogen, because no other gas possesses such inert and negative properties, or manifests so little tendency to combine with other bodies.

Another gas, known by the names of carbonic acid, carbonic anhydride, choke-damp, &c., is a *constant* constituent of the atmosphere, although it is present in very small quantities only, varying from 3 to 6 parts in 10,000 of air. This gas is expelled from the lungs of animals by the act of breathing, and is produced by the combustion of coal, wood, candles, &c., by fermentation, and by the decay of animal and vegetable matter. It acts as a strong narcotic poison upon animals, who are unable to breathe it unless it is mixed with about 200 times its volume of air. But, although it is so deleterious to animals, it is *essential* to the life of plants, which, without it, would soon wither and die. During the day, a healthy plant has the power of absorbing carbonic acid from the air, by means of the countless pores on the under side of its leaves. It appropriates the carbon of the gas to its own wants, and evolves the oxygen with which the carbon was combined. We have here a beautiful view of the *mutual adaptation* of the animal and vegetable kingdoms: animals take oxygen from the air, and exhale carbonic acid, whilst plants absorb carbonic acid, and restore oxygen—thus preserving the purity of the atmosphere.

A fourth *essential* constituent of the atmosphere is *water*, in the form of *vapour*. At all temperatures water is continually rising into the air by evaporation; and the hotter the air is the greater the quantity of moisture it holds in suspension. The amount of aqueous vapour in the atmosphere is therefore variable, being dependent upon the climate, the season of the year, the presence or absence of large tracts of water in the vicinity, &c. A little reflection will show how indispensable is this ingredient of the atmosphere, for without it there would be no genial showers, no refreshing dews, no clouds, no mists, no snow, no hail. And further, if we were surrounded with a perfectly dry atmosphere, the leaves of the trees would shrivel up and fall off, and we ourselves should soon become ghastly mummies. It is the absence of moisture which, in great measure, makes the Simoon, and other winds of the desert, so injurious to animal and vegetable life.

Besides the four *essential* ingredients already mentioned, the atmosphere contains very small quantities of other volatile substances, which must generally be regarded as *accidental impurities*; except, perhaps, in the the case of *ammonia*, traces of which are *always* present, and which is known to be beneficial to growing plants.

As the air of some districts is undoubtedly better adapted for imparting health and vigour to the human frame than that of others, it was naturally imagined that, in healthy situations, the atmosphere contained more than an average proportion of oxygen, or *vital air*, as it was termed. Such, however, is not the case, for the proportions of oxygen and nitrogen in the air are the same in all regions of the earth, and at all altitudes; but the amount of impurities present is very variable.

The mechanical and physical properties of the atmosphere are so well known that we shall only allude briefly to the more important of them. Being a gas, the air is extremely compressible and elastic; and, like all other material substances, it possesses weight. At the level of the sea it exerts a pressure of nearly fifteen pounds on every square inch of surface; and this property has been turned to good account in the construction of the barometer and the common pump, and in numberless other instances. In small quantities the air is perfectly transparent and colourless; but, when viewed in large masses, it presents a blue appearance. It is tasteless and inodorous; for, were it otherwise, our senses of taste and smell would be of little use to us. The faculty of speech likewise would have been given to us in vain if the air had not the power of transmitting sound. Again, were there no atmosphere, there would be no twilight; so that, without a moment's warning, we should be suddenly plunged from the brightness of mid-day into the gloom of midnight. In short, no one can study the composition and properties of the atmosphere without being struck with the many proofs afforded of the infinite power, unerring wisdom, and kind beneficence of its Great Creator.

> ‘But not alone in yon stupendous spheres
> His power immense, His majesty appears:
> We view His kind, His life-preserving care,
> In all the wondrous properties of air.’

G. H. G.

SOUND.

com-par′-a-tive-ly (L. comparo), *by comparison*
reg′-u-lar-ly (L. regula), *in a regular manner*
am′-pli-tude (L. amplus), *largeness, extent, capacity*
re-flect′-ed (L. reflecto), *bent or thrown back*
e-last′-ic (Gr. elauno), *springing back*
di-rec′-tion (L. dirigo), *aim, a command*
in-vis′-i-ble (L. invisus), *that cannot be seen*
mem′-brane (L. membrana), *a thin skin formed by fibres*
per-ceiv′-ed (L. percipio), *seen, understood*
con-vey′ (L. conveho), *to carry, to transmit*

There are few things in Nature that give us more pleasure than to hear sweet sounds, such as the gentle rustling of the wind through the leaves, the low murmuring of a brook, the sweet singing of birds, and especially the merry voices of little children at play. And perhaps there are few things grander than the loud howling of the wind in a tempest, the roaring of the lion, a waterfall, or the sea, or the awful crashing of the thunder-clap in the mountains.

Most people have often heard sounds such as these, but comparatively few people have any knowledge of their nature and their cause. Let us look into the matter a little, and see if we can understand what sound really is.

If you take hold of one end of a long rope, the other end being fixed to a wall, and regularly move your hand up and down, you will throw the rope into a number of ridges and hollows which will make their way along the rope one after the other at regular distances apart. These ridges and hollows are called *waves*. You will notice that the different parts of the rope move *up and down* only, and not *onwards* towards the wall. It is only the *form* of the wave that moves onward.

The distance from the top of one ridge or crest to the next, or from the bottom of one hollow or trough to the next, is the *length* of the wave, which depends upon the quickness with which you move the hand. The quicker you move your hand up and down the *shorter* will be the waves.

Again, the distance which any part moves up and down is called the *amplitude* of the wave, which depends upon the force with which you move your hand—the greater the force the greater the amplitude. Notice further that the farther the wave from the hand the smaller is the amplitude, though the length of the wave remains the same. You know that if you throw a ball against a wall it will rebound or be reflected back to you again, and the more elastic the ball and the wall are, the better the ball will rebound. You will also find that not only will a wave pass along the rope from your hand to the wall, but one will be reflected from the wall to your hand. We may call this *a rope echo*. The like thing takes place when a wave of water strikes against a wall or rock.

If you lay on the floor a train of elastic balls or marbles close to one another in a straight line, and then give the first a tap in the *direction of the line*, the tap will be carried from ball to ball through the train, each ball springing back again when it has given up the tap. Thus a sort of wave passes through the row. If the row be long enough, the force will die out before the end is reached, but if not, the last ball, having nothing to strike against, will fly from the rest. Should it strike against a wall with sufficient force it will rebound and cause a *return wave*, a sort of echo, through the row.

If you put one end of a string or brass wire under your foot, stretch it with one hand and pluck it in the middle with the other, the string or wire, being elastic, will vibrate backwards and forwards till, when the force is spent, it comes to rest. But as the string vibrates you hear a certain sound, which becomes fainter and fainter, dying out with the vibration of the string. Whence comes this sound? Between you and the string are rows of *invisible walls*, atoms of air. As the string vibrates it strikes against the atoms next to it, driving the atoms against one another, till at last those in your ear strike against a membrane, like the parchment of a drum, which conveys the force to a nerve which in turn conveys it to the brain, where it is perceived as *sound*. The same thing takes place when you strike a bell, tuning-fork, or any sounding or *elastic* body.

As the string vibrates backwards and forwards it causes the atoms of air to swing backwards and forwards too for short distances. The distance each atom swings is called the *amplitude*, which depends upon the force with which you pluck the string or strike a bell.

If you pluck the string with greater force you make it swing wider but not quicker than before; the atoms of air swing wider, strike the ear with greater force, and you have a *louder* sound. Thus loudness depends upon the force of the vibration.

The atoms are also in places *crowded* together and in others not. These crowded and uncrowded parts are at the same distance apart in the *same sound*, and the distance from one crowded part to the next is called the *length* of a wave of air or sound.

If you shorten the string it will vibrate more quickly than before, and make shorter waves of air, and you know you get a *higher* note or sound. But if you lengthen the string it will vibrate more slowly, make longer waves, and you will get a *lower* note. So that the *pitch* of the sound depends upon the *rate* of vibration. Thus with strings and pipes of different lengths we get higher or lower notes from the piano, the organ, or a boy's throat.

When a wave of air strikes against a wall, before it dies out it is reflected as an echo. And sometimes a sound is reflected again and again many times. For instance, there is said to be a place in Woodstock Park, near Oxford, where a shout is repeated as many as twenty times. Most large buildings, such as churches, school-rooms, and the like, produce very disagreeable echoes, especially when empty. The echoes under the dome of St. Paul's Cathedral are so troublesome as sometimes to draw away one's attention from the preacher's voice. Echoes are common in the squares of towns and in mountainous and rocky districts of the country.

At some distance off you see a man cutting down a tree. You see the axe fall, and *presently* you hear the sound of the blow. Or a man is about to fire a gun, you see the flash, and *presently* you hear the report. How is this ? If you were near these men you would hear the sound as soon as you saw the flash or fall of the axe. A boy standing farther away than you would not hear the sound so soon, nor would it be so loud to him. A sound-wave takes time to make its way or to travel from one place to another. It has been found that sound travels in a *frosty* day 1,090 feet, and in a *warm* day 1,120 feet in a second, or about twelve miles a minute; so that if we see the flash of a gun or of lightning, and notice the time by a watch when we hear the report, we can tell how far off we are from the gun or the thunder-cloud.

But air is not the only thing which will convey sound. If one boy tap one end of a long iron fence, a second boy, with his ear *close* to the other end, will hear the tap sooner and better than a third boy who is standing a little distance off. The atoms of iron convey the tap more quickly than the atoms of air. So a slight scratch, or the ticking of a watch at one end of a long piece of timber, can be much more distinctly heard if you place your ear against the other end than if you do not

You may illustrate this yourself by a simple and amusing experiment. Take a piece of common string about a yard long. Make a loop in the centre and pass a poker through it, so as to be supported by the loop. Now put one end of the string into one ear, and the other into the other. On striking the poker lightly against the wall, or any other hard substance, you will hear a sound like a large church bell.

It has been found that sound travels about sixteen times as fast along iron and wood, and four times as fast in water as in air, these substances being more elastic than air.

H. T.

HEAT.

ob-tain′-ing (L. obtineo), *gaining, procuring*
ma-chin′-er-y (Gr. mechanè), engines
fric′-tion (L. frico), *the act or effect of rubbing*
un-pleas′-ant (S. un, L. placeo), *in a manner not pleasing*
per-cus′-sion (L. percutio), *the act or effect of one body striking another*
ther-mom′-e-ter (Gr. thermos, metron), *an instrument for measuring heat*
con-duct′-or (L. conduco), *a leader*
sub′-stance (L. subsisto), *something existing, a body*
vi-bra′-tion (L. vibro), *quivering, the act of moving backward and forward*
ra′-di-ate (L. radio), *to emit rays*

Everybody knows that we get heat from the sun and from our fires. But are there no other means of obtaining heat than these? Perhaps not in the long run; but let us see.

What boy has not often rubbed a button on a form till he has made it hot enough to burn his own hand, or, more generally, his neighbour's? Do we not often rub our hands and our feet to make them warm? Sometimes this rubbing becomes a more serious matter. You have perhaps heard or read that forests have been set on fire by the rubbing of two branches together in the wind. You have seen people oiling or greasing the wheels of machinery or railway carriages. Why is this? It is done to prevent the rubbing of the wheels and axles, which would make them so hot as to set fire to the woodwork of the carriage or wear out the machine. In spite of this greasing, railway carriages have been set on fire by the rubbing of the wheels and axles. Now rubbing of any kind is called *friction*, which, as you see, is a source or cause of heat.

We not only rub our hands and feet to make them warm, but we clap our hands and stamp our feet for the same purpose. I suppose there are few boys who do not know what it is to have some part of their bodies warmed unpleasantly by a fall or a blow. You must often have seen sparks of fire fly from under a horse's foot when he has kicked against a stone, or, perhaps, even you have struck fire in the same way with the heel of your boot. Take a large nail, and hammer it well on an anvil; you will soon make it too hot to hold. Further, you may shake cold water in a bottle till you make it and the bottle quite warm. We then get heat by hammering, or *percussion*, as it is called.

Again, mix together a little vitriol and water, both cold, in a glass; they will make one another and the glass quite hot. Pour some water on quicklime, and the heat will become great enough to set paper, shavings, and wood on fire. Men who work about buildings frequently roast potatoes and cook meat in slaking lime. Boys who live in the country must know very well that in showery weather farmers sometimes put their hay into a rick before it is dry. By and by it begins to smoke, and the rick has to be taken to pieces quite charred and black within, if it has not already taken fire. You know that if you eat a good dinner you feel warmer after than before, even if the food be not so warm as your own body. In some way the food has given you heat. If you were to burn that food, would it give you as much heat, if you could catch it all, as when you eat it? Just as much, and no more. Indeed the fire may be said to eat the coal which it burns, and you to burn in your body the food which you eat. In all these instances some change takes place in the vitriol, the water, lime, grass, and the food, called a *chemical* change, which change is the cause of heat.

I put one end of a poker and of a stick of the same length into the fire, and presently I touch the other end of each. The poker is hot, but the stick is no hotter than before. I let them stay longer; now I cannot bear my hand on the poker, but the stick is scarcely warm, although it is partly burnt away. The thermometer, of which I shall have to speak by and by, tells me that all the things in the room except those close to the fire are equally warm. I touch the door-handle, the key, and other metals about the room; the woodwork, the wall, the table-cover, and the carpet. My hand tells me they are not equally warm, but that the metals are colder than the wood, and the wood colder than the table-cover and the carpet! Which am I to believe, my hand or the thermometer? Now the thermometer in such matters is a better judge than my hand, and I must believe it.

Then how is it that, of things equally warm, some *appear* warmer than others? In the case of the poker and the stick in the fire we found the poker much hotter than the stick, though they had been in the fire the same time. The fact is, the heat made its way along the poker very much faster than it did along the stick, for which reason the poker is said to be a *better conductor* of heat than the stick, or that iron is a better conductor of heat than wood. When I touched the metals in the room, they felt colder than the wood, and the wood colder than the woollens—that is, the metals being good conductors, and colder than my hand, carried away the heat from my body much faster than the other substances, which are *bad conductors*; the woollens being worst of all.

You see now why we take hold of the hot handle of the kettle with a woollen holder, why we cover our floors with carpets and our bodies with flannel, and why birds and beasts are clothed with feathers and furs. Air is one of the worst conductors of heat, so people in cold countries have double doors and windows, and birds ruffle their feathers in cold weather.

I stand before the fire or in the sun, and the heat warms me; and the more I get in front of the fire, the more heat I receive; the more I go from the front of the fire towards the sides, the less heat I receive, although I do not get any farther away. In the same manner those countries which have the sun overhead receive very much more heat and are hotter than those to the north and south, where the sun is never overhead.

But how does the heat from the fire or the sun come to me? What is there to conduct or bring it? You will perhaps reply that the air brings it. But you learnt just now that the air is a bad conductor; and, if it were not, it behaves in such a way, as you will see by and by, as to rob me of heat rather than to enrich me. Then you will very likely think, as nearly everybody else used to think, that the heat must dart out from the fire and from the sun. But it is pretty certain that heat is not a thing which can thus dart out of one substance into another; for if we make a substance never so hot, it does not become any *heavier*, and if it grow never so cold, it gets no *lighter*.

If then the air does not bring the heat of the fire or of the sun to me, and if it does not dart out against me, there must be something else between the fire and myself, along which the heat can travel. You will remember that in the lesson on Sound we learnt that the vibrations or tremblings of the atoms of a bell are carried along by the air from atom to atom, till at last the nerve of the ear takes up the tremblings which are felt as sound. Now it is believed that between the earth and sun, and everywhere else, there is a substance very much thinner than air, called *ether*; that the fire, the sun, and other things which give out heat are really in a state of rapid trembling, or vibration, and that the ether carries along the heat vibrations somewhat like the way in which air conveys sound vibrations, and as the poker conveyed the heat vibrations, only exceedingly faster. When heat is thus conveyed by the ether, it is not said to be conducted, but *radiated*. The body which gives out the heat is said to radiate it, and that which is warmed by it is said to *absorb* it.

If you put a bright metal teapot and a dark earthenware one full of hot water upon the table, they will both begin to radiate their heat, and will in time become cold. Which do you think will win the race, or get cold first? Try it. You will find the black teapot will win. Put them both before the fire full of cold water. Now, which will get hot the first? We shall find the black teapot will win again. That is, the teapot which radiated fastest will absorb best. And, generally, you will find that dark rough substances absorb and radiate well, while bright smooth substances absorb and radiate badly. You will now, I think, understand why it is that people in hot countries wear light-coloured clothing, and why the driver keeps his engine so bright.

But what becomes of the heat radiated against the bright teapot? In the lesson on sound it is explained that the vibrations are reflected or thrown back when they strike a wall. In like manner the bright metal reflects the heat vibrations. So bright metals are good reflectors of heat.

I cannot in this lesson say more than a few words about the work which heat does; for heat really does a vast amount of work. One might almost say it does all the work in the world.

It does chiefly two things. It *warms* bodies and expands them, or causes them to swell out. Hold a bladder half full of air before the fire. The bladder swells out, and becomes ready to burst. The heat warms the air, and drives the atoms away from one another against the sides of the bladder, which they drive out, lifting back the air outside. But the half bladder, say a quart, has become two quarts without becoming heavier. So, then, warm air is lighter than cold, and, if lighter, warm air will rise and cold air sink.

You will now understand how it is that smoke and flame rise when we light a fire.

Fill a phial full of quite cold water, and put it into a basin of warm water. The heat will expand the water in the bottle and make it run over. The more you heat it, the more it will expand. Leave your kettle on the fire, what becomes of the water? You say it is all boiled away. But where has it gone?

The heat of the fire has expanded it into vapour, making it take up nearly 1,800 times as much room as before. The sun is continually doing work of this kind.

But heat expands most other things besides air and water. If you heat an iron rod, it will become longer and bigger than before. Small spaces are left between the metals on a railway because in summer the metals become a little longer than they were in winter.

H. T.

RAIN, HAIL, AND SNOW.

at′-mo-sphere (Gr. atmos, sphaira), *the air which encompasses the earth*
ab-sorb′ (L. absorbeo), *to suck up*
re-lax′ (L. relaxo), *to loosen, to slacken*
ex-pand′ (L. expando), *to spread, to lay open*
sat′-u-ra-ted (L. saturo), *filled, till no more can be received*
con-tin′-u-al-ly (L. continuus), *unceasingly*
con-dens′-ed (L. con densus), *made more dense or thicker*
re-maind′-er (L. remaneo), *that which is left*
cen′-tral (L. centrum), *relating to the centre*
un-for′-tu-nate-ly (S. un, L. fortuna), *not prosperously, unhappily*

Every boy who reads this book is pretty sure to have learnt that the earth on which we live is surrounded by a covering of air called the atmosphere, which reaches more than fifty miles high, getting thinner and thinner the farther we go from the earth, and in which birds and insects fly as fishes swim in water.

I daresay you have often noticed that, if you leave your inkpots uncovered for any length of time, the ink soon becomes thick, and at last disappears, especially in the summer. You may also have frequently noticed that the water in open vessels, puddles, and ponds disappears in dry hot weather. What has become of the water, of the ink, and of the puddles and ponds? You will at once reply that the sun has dried them up; that is, the heat of the sun has changed the visible water into invisible vapour. Now, as a gallon of vapour is much lighter than a gallon of air, the vapour rises into the air, which holds it up as it holds up dust and other substances lighter than itself.

In the tropics, where the sun is always overhead, and where it is, therefore, very hot, a very great deal of vapour is thus raised into the air, some of it being carried by winds over other parts of the world, so that there is always more or less vapour in the atmosphere.

If I slightly squeeze a sponge, and so dip it into a vessel of water, the sponge will absorb or dry up as much as my hand will allow it to hold, and no more. Now if I relax the sponge or squeeze it less, it will expand and drink up more water, and so on the less I squeeze it. In each instance it will absorb as much as it can hold, or it will become *saturated*. But if I squeeze the sponge when it is saturated, the water will fall out, and the more so the more I squeeze it.

The air in this respect behaves somewhat like a sponge. You remember reading in the lesson on Heat that when air is warmed it expands, becomes lighter than before, and rises. Now warm, expanded air will hold more vapour than cold, dense, or unexpanded air, and the more it is warmed the more vapour will it contain. So you see that heating the air is very much like relaxing the sponge.

But as the sun is continually lifting the water into the air, the air must in time become saturated with vapour, and unable to hold any more. In that case a slight squeeze will drive the vapour out as the water was squeezed out of the sponge. But what hand is there to squeeze the atmospheric sponge? You will not have forgotten that when the expanded bladder of air was removed from before the fire, as it cooled it shrank up into its former size; that is, the air was condensed on losing heat.

Again, you must have often noticed the cloud of mist a little way from the spout of the tea-kettle, though you could see nothing close to the spout. And you have frequently seen the like clouds issuing from your own nostrils and from the nostrils of other persons, and of horses on a cold day. How is this? Vapour comes from your nostrils in the summer time, though you do not see it then, but may easily catch it by holding a cold plate before your nose. The truth is, your warm breath, which contains invisible vapour, meets with colder air, which robs the breath of its heat, condenses it, and the vapour is, as it were, squeezed out, the vapour itself being also condensed.

Now the higher we ascend into the air the colder and thinner it becomes. The vapour of the tropics is carried up by the heated air into the cold regions of the atmosphere; there it parts with its heat and is condensed or squeezed out, falling down as rain in such a way as you have never seen it rain in England. Some of the vapour is, however, carried by the warm air to the Northern and Southern regions, where it meets with colder air and is there condensed.

In some parts of the world—for instance, on the coast of Peru, along the northern part of Africa, the Desert of Arabia, and Persia—it hardly ever rains; in some others it rains nearly every day; for example, the north-east coast of North America, the west of Ireland and Scotland; and in other parts, as you know—for instance, India and Palestine—it rains only at certain seasons, being dry during the remainder of the year.

It is said that in one place in the tropics about 50 feet of rain fall in a year; that is, it would require a cistern 50 feet deep to hold all that falls over the cistern. At Cayenne, in South America, 21 inches have fallen in a day. In England about 30 inches fall in a year; that is, enough falls in a year to cover the whole of England 30 inches deep if it all remained on the surface. In Cumberland as much as 127 inches fall yearly; but in other parts much less than 30 inches.

Hail.—Hailstones are often very much like little hard snowballs, which seem to have come from, or passed through, cold layers of air. It is not always easy to say how they are formed, but we may notice that hailstones are commoner in summer than at other times, and during thundery weather, when the air frequently changes very suddenly from heat to cold, and from cold to heat. It may be that they were first of all drops of rain, which became frozen in falling through a colder layer of air.

Sometimes hailstones are so large as to be really lumps of ice, when they do serious damage to the vines, young shoots of trees, and the crops of corn. Indeed some of the more prudent of the farmers insure their crops against hailstorms.

Snow.—What is this very beautiful substance? Another form of condensed vapour frozen before it was able to form drops of rain — frozen mist. Beautiful as it is when lying as a fleecy blanket—for a blanket it really is—upon the ground, or as it weighs down the branches of trees, it is not often seen in its most perfect beauty. When the air is very calm, snow falls as stars, with six rays all starting out at the same distance from a central spot, these rays having others starting out from them, forming stars of many shapes, yet all being wondrously beautiful. A few weeks ago I had a better view of these snow stars than I had ever had before, but unfortunately they did not remain more than a few minutes.

In some countries the people never see snow, and we in England do not see it every winter, except it may be on the high hills in the north. But in other parts, as in Greenland, snow lies on the ground all the year long, even near the sea level; and even in the tropics the mountains beyond 16,000 feet above the sea are always covered with snow. In the Alps, in Switzerland, the snow line, as it is called, is about 8,000 feet above the sea.

You see, then, that in very high regions, and towards the Poles, the vapour of the tropics is condensed in the form of snow instead of rain.

H. T.

VOLCANOES.

de-scend'-ing (L. descendo), *going or coming down*
in'-fi-nite-ly (L. in, finis), *without limits*
e-nor'-mous (L. e, norma), *beyond rule or measure, excessive*
un-breathe'-a-ble (S. un, breath), *not able to be breathed*
ac-com'-pan-ied (L. ad, con, panis), *joined with*
con'-i-cal (L. conus), *having the form of a cone*
vol-ca'-no (It.), *a burning mountain*
oc-ca'-sion-al-ly (L. occasio), *at times*
flour'-ish-ed (L. flos), *thrived, became prosperous*
frag'-ment (L. frango), *a part broken off*

There are very few people indeed who have not seen a chimney on fire. You have perhaps stood and watched the thick smoke and soot rising up and darkening the air, and presently descending and covering the neighbourhood with a black coat. Now and then huge flames issue forth with a loud roar, and light up the air, especially if in the night. Or, perhaps, you have seen the far grander fires, and heard the loud roar of the blast-furnaces, in the iron districts of South Wales or Staffordshire. If so, you will not easily forget them, for they are some of the grandest of sights.

But there are furnaces and chimneys in some parts of the world, though not in England at present, compared with which our blast furnaces are quite babies; and these furnaces were not made and are not worked by man, but by a power infinitely greater than his—even by Nature herself. The great earth is the furnace, and the volcanoes, or burning mountains, of which, it may be, you have heard already, are the chimneys, which are not a few feet only, but even thousands of feet high, and they do not merely throw out the smoke of unburnt coal, but volumes of steam which subsequently descend in torrents of rain. Clouds of ashes, which ascend far up into the air and darken the sun for days, are carried hundreds of miles off, and fall down, breaking in the roofs of houses, breaking down the branches of trees, burying animals, and covering the ground with a thick coat. Besides these, rivers of hot mud and white hot melted rock flow out for miles, carrying everything before them. Enormous stones of many tons weight are hurled high into the air again and again, and gases of all sorts issue forth, making the air unbreatheable. All this is accompanied with awful noises, which may be heard sometimes hundreds of miles off.

A volcano called Cosaguina, in South America, broke out in 1835, and threw out such a quantity of sand and cinders that the ground to a distance of twenty-five miles was covered more than ten feet thick, burying woods, villages, people, cattle, and wild animals. Some of the finest of the ashes were thrown up so high that they fell four days after upon the Island of Jamaica, 700 miles eastward. Account is given of another volcano whose ashes broke in the roofs of houses forty miles off, some being carried to a distance of 800 miles, and whose noise was heard 1,000 miles away.

A volcano is, in general, of a conical shape, with a hollow in the top, called a crater—somewhat like a basin turned bottom upwards, only not quite so regular; or like a wide-awake hat, with a hollow made in the crown; or like a mole-hill, with a similar hollow. Some of them are quite small mounds, but others are immense mountains thousands of feet high, whose craters are sometimes three or four miles across and more than 1,000 feet deep. These craters are the mouths of funnels or chimneys which reach down to a great depth in the earth, and which, even when the volcano is not at work, contain great quantities of molten rock called lava, only waiting to be driven out by the furnace below. The sides of such a volcano are often covered by as many as 100 smaller cones, each of which is really a large hill.

Now there are a great many volcanoes in different parts of the world, which are either always or occasionally at work; perhaps as many as 300. Of these there are two very famous ones in the south of Europe, namely, Vesuvius and Etna, and one in Iceland named Hecla, concerning each of which I must say a very few words.

Vesuvius, from which our vesuvian matches derive their name, is near Naples, in Italy, and about 4,000 feet high. It has a large crater, which at one time was 4,000 feet across and 2,000 feet deep. Sometimes Vesuvius is quiet for years, only known to be alive by a faint wreath of smoke which issues from it, or a light cloud of vapour hovering over the top. But all at once a loud noise is heard, the ground trembles, and out bursts the volcano in terrible fury, to continue for months or even years. For centuries Vesuvius had been slumbering, villages were built on its sides, its slopes were clothed with cornfields and vineyards, and cities flourished at its foot; even the inside of the black crater was made beautiful by wild plants. At last, in 63 A.D., an earthquake shook down houses and temples, and eleven years afterwards, the choked-up chimney was opened, and out burst the ashes, cinders, mud, and lava, which darkened the sky, poured down the mountain sides, sweeping away the villages, and burying two seaport towns at the base. Pompeii was buried by ashes and mud, and Herculaneum by lava. Hundreds of years after, the lost and almost forgotten cities were discovered, and are even now being explored.

Etna, in Sicily, is larger than Vesuvius. It is 11,000 feet high and about 80 miles round the bottom, having more than 100 smaller cones on its sides. Like Vesuvius, it breaks out only occasionally. In 1669 Etna poured out a stream of lava which flowed fifteen miles, burying small towns and villages, and at last reached the walls of Catania, which it overflowed, destroying part of the town. Since then Etna and Vesuvius have had many eruptions, the last of which occurred only three or four years ago.

Hecla is in the south of Iceland, and is generally active. In the year 1783 a fearful eruption took place. Two rivers of lava were poured out, one reaching forty miles and the other fifty. The average breadth of one was seven and the other twelve miles, and they varied in depth from 100 to 600 feet. Masses of lava such as these flow very slowly, and soon cool on the outside, forming a crust which shuts in the heat, so that the lava remains hot for years. In 1845 ashes were blown from Hecla to the Orkneys, at the north of Scotland, a distance of 700 miles.

Volcanoes are generally found in the mountains on or near the sea coast. Thus they fringe the coast of the Pacific, forming a broken ring of volcanoes from the islands south of Cape Horn, along the Andes and Rocky Mountains, and across Kamtschatka through the East Indian Islands to New Zealand. So also in the Indian Ocean, the West Indies, and the Mediterranean. In the Island of Java, in the East Indies, there are no fewer than forty-five volcanic chimneys, some of them 14,000 feet high, twenty-eight of them being active.

Now, whence came these monstrous chimneys? Have they always been where and as they are now? By no means. There are good reasons for believing a statement, which in time you will understand, if you take the trouble, that these burning mountains, vast as they are, were built up, comparatively speaking, not long ago; that they are much newer than the very newest of our English hills; much newer, in fact, than Highgate, Primrose, or Sydenham hill upon which the Crystal Palace stands. Moreover, the furnaces, without much doubt, gradually built up their own chimneys with the melted rock they threw out from time to time from within the earth. First of all a crack is made in the rock, and out burst large quantities of melted rock, which are poured out on the plain around. More is added from time to time, every fresh outburst enlarging and raising the height of the mass till, it may be, the height becomes too great for the furnace, when a hole is burst in the side and a small hill made on the side of the large one.

You will naturally ask, 'What is the force which gives the furnace such power?' It is not very easy to answer this question. But of this we are quite sure, that the deeper we go into the earth the hotter it becomes; and it is believed that at the depth of several miles the heat is so great that the rocks are, in some places at any rate, in a very hot, if not molten, state. You will remember that volcanoes are generally near the sea, and you know that when the water in a kettle is heated the heat will often drive the water out at the spout and lift up the lid, and if the spout and lid were stopped, would very soon blow the kettle to atoms. Now it is thought that water sinks down into the hot parts of the earth, becomes intensely heated, and not being able to expand is endued with terrific force which enables it to open cracks in the rocks, and force the melted matter through till its force is spent, when all becomes quiet again for a time.

I said at the beginning that there were no volcanoes in England *at present.* This is true. But just as there are ruins of blast furnaces, so there are ruins, sometimes only fragments, of old volcanoes, even here as in almost all other parts of the world. In the Malvern hills and other parts of the West of England, and in North Wales, Scotland, and Ireland, there are abundant remains of old volcanoes. Snowdon and Cader Idris are mostly made of volcanic ashes and lava; and in Auvergne, in France, there are some remains of old volcanoes, though much newer than the British ones, which are almost perfect, but which have been silent for ages, it may be never to re-awaken.

H. T.

ELECTRICITY.

phys′-i-cal (Gr. physis), *relating to nature*
phi-los′-o-pher (Gr. philos, sophia), *one who is well versed in any science*
ad-here′ (L. ad, hæreo), *to stick to*
am′-ber (Ar.), *a yellowish fossil resin, found abundantly on the shores of the Baltic, &c., and much used for pipe mouthpieces*
vul′-can-ite, or ebonite, *a black, hard, elastic substance, resembling horn in appearance, and much used for combs*
ap-par′-ent-ly (appareo), *seemingly, but not really*
e-lec-tri′-cian (Gr. elektron), *one who understands electricity*
con-duc-ti-bil′-i-ty (L. conduco), *power of conducting electricity*
gen′-er-ate (L. genero), *to produce*
res′-er-voir (Fr.), *a place where anything is kept in store*
sens′-i-ble (L. sensum), *capable of being perceived by the senses*
ap′-pli-ca-ble (L. applico *proper to be applied*
in-stan-ta′-ne-ous-ly (L. insto), *in a moment*
graph′-ite (Gr. grapho), *another name for black-lead, or plumbago*
con′-cen-tra-ted (L. con, centrum), *strong, not dilute*
sa-line′ (L. sal), *consisting of salt*
lu′-mi-nous (L. lumen), *emitting light*
phys-i-o-lo′-gi-cal (Gr. physis, logos), *relating to physiology, which treats of animals and plants*
per-pet′-u-al (L. perpetuus), *permanent, never ceasing*
ap-pa-ra′-tus (L.), *instruments necessary for any art, science, or trade*
sul′-phur (It.), *another name for brimstone*
cyl′-in-der (a) (Gr. kylindros), *shaped like the stone of a garden roller*

ELECTRICITY is that branch of physical science which investigates a very peculiar power or property produced in natural bodies by friction and other means. The word electricity is derived from the Greek word *electron*, amber, because the electric property was first observed in that substance by the Greek philosopher Thales, B.C. 600.

If you lay a *warm* sheet of smooth brown paper on a metal tea-tray, and rub it well with india-rubber or a soft hat-brush, you will find the paper will exhibit certain peculiar properties which it did not previously possess. The friction, or rubbing, has developed in the paper the power of attracting to itself, and afterwards repelling, certain light substances, such as the down of feathers, metallic leaf, bits of tissue paper, filings of cork, pith of elder, bran, &c. On bringing the paper near your skin, a sensation will be produced like that experienced when a cobweb is drawn across the face; and if it be held over the head of a person whose hair is perfectly dry, the hairs under it will be attracted, and made to 'stand on end.' If the rubbing be performed in a dark room, a faint bluish light will be emitted, a sharp crackling sound will be heard, and small sparks will be visible when the paper is lifted off the tray. If you hold the paper by one of its corners, it will move towards your body or towards the wall, to which it will adhere for a short time. The paper is said to possess these properties because it is *electrified*, or *electrised*; and while it possesses them it is in an *electrical* or *excited* condition. It does not, however, retain its electrical powers for any considerable time; but it can be electrified over and over again, by holding it before the fire until it is quite hot, and then rubbing it as before.

Other substances can be made to produce similar effects when submitted to friction, especially amber, gutta-percha, vulcanite, the skin of a cat, sulphur, sealing-wax, glass, &c.

On the other hand, there are many bodies, such as the metals, in which, *apparently*, this peculiar power cannot be developed.

This difference in the behaviour of substances when rubbed, *under ordinary circumstances*, led the earlier electricians to divide all bodies into *electrics* and *non-electrics*; because they supposed that, while the former were capable of being electrified by friction, the latter were not. This classification was afterwards shown to be incorrect, for subsequent experiments proved that the so-called *non-*electrics *could* be electrified by friction, if the operation were properly performed. It was discovered that the reason why a rod of metal does not evince any electrical powers when held in the hand and rubbed with a woollen cloth, as a rod of glass or sealing-wax would do under similar circumstances, is because of its *conductibility*. The electricity generated by the friction of the cloth is *conducted* by the metal rod to the hand of the operator, through whose body it escapes, as fast as it is produced, to the earth, which is the great reservoir to which all free electricity endeavours to return. Hence, no sensible trace of it is to be found on the surface of the metal. But if the rod of metal be inserted in a piece of glass tubing, and the glass be used as a *handle*, the metal rod can then be excited, and will retain its electricity. We see, then, that the terms *electrics* and *non-electrics* are no longer applicable, because *all* bodies can be electrified by friction.

Another classification has therefore been adopted, which arranges all substances into *conductors* of electricity and *non-conductors*. Conductors are those bodies which permit electricity to travel freely along their surface; whilst those which do not are termed *non-conductors* or *insulators*. The difference is one of *degree*, not of *kind*; since there is no such thing as a perfect conductor or a perfect insulator. The very best conductors offer a certain resistance to the passage of electricity, and the very best insulators permit it to a small extent.

The best conductors are the *metals*, which transmit electricity instantaneously. Next in order of conducting power come graphite, concentrated acids, saline solutions, water, the human body, vegetable substances, &c. The best non-conductors are resins, gums, gutta-percha, india-rubber, silk, glass, *dry* air, &c.

Frictional electricity can be made to produce startling mechanical, luminous, heating, and physiological effects; but in order to exhibit these we require an *electrical machine*, and a *Leyden jar*.

The first electrical machine was constructed about 1647. It consisted of a globe of brimstone, mounted on an axis, and made to revolve rapidly against the hand. The globe of sulphur was afterwards replaced by a *hollow cylinder of glass*, which was excited by pressing against a cushion, or *rubber*, made of soft leather, stuffed with wool or hair. A *circular plate* of glass was subsequently substituted for the *cylinder*; but both these forms of the electrical machine are expensive.

What Cavallo calls 'a machine for exhibiting *perpetual* electricity' may be constructed for a few pence by any boy who will observe the following instructions:—Get a child's tin plate, which can be purchased at any toy-shop for a penny. Heat the bottom of the plate over a candle, and fix the *end* of a stick of sealing-wax in the middle of the upper side of the plate, so as to form an insulated handle for lifting the plate. Then take a piece of warm brown paper, a little larger than the plate, and put it upon a metal tea-tray, standing on a wooden table. Excite the brown paper in the manner already described, place the tin plate upon it, and, after touching the plate with the finger, lift it *quickly* off the paper by the insulating handle; then, on applying the knuckle to the rim of the plate, an electric *spark* will be received. This may be repeated for about a hundred times in frosty weather, if the apparatus be kept warm and dry, without exciting the paper afresh.

This machine is called an *electrophorus*, and may be used for charging a Leyden jar, and for other electrical purposes.

G. H. G.

ELECTRICITY (*continued*).

pre-ce′d-ing (L. precedo), *going before*
ar-ti-fi′-ci-al-ly (L. ars, artis, facio), *not naturally, by man's skill*
at′-mos-phere (Gr. atmos, sphaira), *the air*
i-den′-ti-ty (L. idem), *sameness*
au-ro′-ra bo-re-a′-lis (L.), *northern lights*
phe-nom′-e-na (Gr.), *appearances*
re′-cent-ly (L. recens), *lately, freshly, not long since*
im-merse′ (L. immergo), *to dip into some fluid*
a-cid′-u-late (L. acidus), *to make sour*
sub-serv′-i-ent (L. subservio), *useful for promoting some purpose*
fra′-gile (L. frango), *brittle, easily broken*
bril′-li-an-cy (Fr. briller), *brightness, splendour*
su-per-sede′ (L. supersedeo), *to set aside, to take the place of another*
blast′-ing, *a mode of detaching large masses of stone, coal, &c., in quarries or mines, by means of gunpowder or other similar substance*
con-ceal′-ed (L. con, celo), *hidden*
par-al′-y-sis (Gr.), *palsy*
tic doul′-ou-reux (Fr.), *a very painful affection of the nerves*
cleav′-age, *the act of splitting or cleaving*
re′-search, *diligent inquiry*
se′-pa-rate (L. separo), *distinct*

In the preceding Lesson we spoke of electricity being produced *artificially* by the friction of dissimilar substances, but it is also a *natural agent*, existing and acting in the atmosphere. Sometimes the air becomes *overcharged* with electricity, and then we have what is known as a thunderstorm, during which electricity is discharged from the clouds to the earth in the form of *lightning*. The identity of the lightning of the heavens with the electric spark was first established by the famous kite experiment of Dr. Franklin, at Philadelphia, in 1752. Such kite-flying is, however, attended with great danger, and several persons have lost their lives whilst repeating Franklin's experiments, and amongst them Professor Richmann, of St. Petersburg.

This important discovery has enabled us, by a simple and cheap contrivance, called a *lightning-conductor*, to protect buildings and ships from being shattered to pieces by lightning. A lightning-conductor is a long, pointed, metallic rod, placed on the top of a building or mast of a ship, and extending to the ground or sea. By this simple apparatus, a discharge of lightning is conducted silently, swiftly, and safely away.

Atmospheric electricity is also said to be the cause of the *aurora borealis*, 'shooting stars,' and other atmospheric phenomena.

There are many other means of developing electricity besides friction, such as *cleavage*, *pressure*, *change of temperature*, and *magnetism*; but the most fruitful source of electricity is *chemical action*.

Electricity set in motion by chemical action has received the names of *galvanism* and *voltaism*, because the science may be said to be based upon the observations and investigations of Galvani and Volta. Galvani, professor of anatomy at Bologna, discovered, in 1790, that the muscles in the leg of a recently killed frog were contracted when brought into contact with two different metals, such as zinc and copper. Galvani's experiments were afterwards repeated and extended by Volta, professor of natural philosophy at Pavia, to whom belongs the real merit of laying the foundation of this science. His researches led him to the discovery of the *pile*, which was the first galvanic battery ever constructed, and which must be regarded as the origin of all the great electrical discoveries of the present century.

The following is one of the simplest methods of producing a voltaic current, which requires two dissimilar metals, connected together, and immersed in a liquid which acts chemically upon *one* of them in preference to the other. Attach a small plate of copper to one end of a wire, and a similar piece of pure zinc to the other; and then plunge the two plates in a tumbler containing acidulated water. Several pairs of such plates connected together would constitute a galvanic battery, of which there are many different forms, the most noteworthy being the batteries of Grove, Bunsen, Daniell, and Smee. Our limited space will not permit us to describe any of these batteries, so we will proceed to speak of some of the ways in which voltaic electricity has been made subservient to the requirements of man.

Unquestionably, the most important and remarkable use which has been made of electricity is its application to telegraphic purposes, which forms the subject of a separate Lesson.

Another practical application of voltaic electricity has created an important branch of modern industry, known as *electro-metallurgy*, which consists of three branches:—

1. *Electrotyping*, which is the art of producing in metal, by the agency of electricity, faithful copies of coins, seals, medals, statues, engraved plates, &c. This process is also employed for 'manufacturing pipes without seams, boilers, stewpans, and other vessels of copper; for reproducing the plates used to print Bank of England notes; for making casts from metal type and woodcuts; to form rollers of copper for printing or embossing calicoes; to give strong coatings of metal to fragile glass vessels, such as chemical retorts and flasks; to prepare metallic lace and cloth; and to cover delicate flowers and minute insects with durable films of copper.'

2. *Electro-plating*, which is the art of depositing a thin and uniform coating of *silver* upon the baser metals, by means of a voltaic current.

3. *Electro-gilding*, which is identical with electroplating, except that the articles are coated with *gold* instead of silver.

The first successful experiments in electro-metallurgy were made in 1837; but there are now upwards of thirty electro-plating establishments in this country alone, and in some of them several hundred hands are employed.

The *electric light*, which rivals sunlight in brilliancy and power of penetrating fogs, has been successfully employed, both in England and France, for illuminating lighthouses. That at Dungeness has been lighted with it since 1862; and it is possible the electric light may some day supersede coal gas for lighting up streets and public buildings.

A galvanic current has the power of igniting thin wires of comparatively bad conducting metals, such as steel and platinum, if they form part of the circuit. Advantage has been taken of this power for exploding gunpowder at a distance, for *blasting* purposes, and for firing *torpedoes*, which constitute an important means of defence against the approach of an enemy, both by sea and land.

Torpedoes were first used by the Russians, who invented these 'infernal machines' in 1854, as a protection against the British fleet in the Baltic. Their torpedoes, however, were not fired by electricity, but would destroy friend and foe alike, if the ship happened to come in contact with them. Since that time the subject has received much attention from scientific men, and torpedoes now form an important part of naval and military tactics. As much as 500 lbs. of gunpowder are put in a strong iron vessel, resembling the boiler of a steam-engine; it is then sunk a few feet in the sea, or concealed in a pit on the land, to be exploded at any required moment by a galvanic current.

A *time-gun*, consisting of an 18-pounder cannon, is fired at Newcastle every day, at 1 P.M. Greenwich time, by a current from a battery at Edinburgh, 120 miles distant.

The voltaic current has also been turned to good account in the construction of electric clocks and electro-motive engines; besides being used as a curative agent in the treatment of many diseases, especially paralysis, lock-jaw, St. Vitus's dance, tic-douloureux, and deafness.

G. H. G.

THE ELECTRIC TELEGRAPH.

curv′-a-ture (L. curvus), *the continual bending of a thing*	con-tin′-u-ous (L. continuo), *unbroken*
ri′-val (v.), (Fr.), *to compete with, to strive to excel*	gal′-va-nis-ed iron, *iron coated with zinc or tin, to protect it from the action of the air*
pre-cise′ (L. præcædo), *exact*	sub-ma-rine′ (L. sub, mare), *under water in the sea*
es-sen′-tial (L. esse), *necessary, indispensable*	tech′-ni-cal (Gr. techne), *pertaining to an art or trade*
ten′-sion (L. tendo), *the power of stretching out*	mil-len′-ni-um (L. millenænus), *a thousand years*, the thousand years *mentioned in Revelation*
dis′-si-pate (L. dissipo), *to disperse, to scatter*	
cur′-rent (L. curro), *a stream*	

THE *Electric* Telegraph, like every other telegraph, is designed for conveying information to a distance, with great speed. The idea of speed is always associated with telegraphs, because they are only employed when they can transmit intelligence at a much quicker rate than can be done by the ordinary means of transit.

The fleetest messenger is light, but it is not a docile agent. It travels only in straight lines, and will not adapt itself to the curvature and irregularities of the earth's surface. Moreover, the *shutter* telegraph, the *semaphore* telegraph, and all others in which light is the travelling agent, are perfectly useless at night, and in foggy weather.

Electricity rivals light in the speed with which it travels; and it is at the same time a most easily managed and trustworthy agent. 'It silently wends its way in all weathers, over plain and mountain, across sea and land, and delivers its message familiarly in the office or parlour almost at the precise instant it was sent.'

The electric telegraph consists essentially of three parts:—1, *The Battery*, or source of the electric power; 2, *The Line* for transmitting this power; and 3, *The Indicator*, or instrument for exhibiting the signals. Frictional electricity is not adapted for telegraphic purposes, on account of its high *tension* or *intensity*, which would cause it to fly off from the conducting wire, and be dissipated in the air, instead of travelling to a distant station. Hence, we are obliged to employ voltaic electricity, which is of such low tension that it can be made to travel along a wire for any distance. Any of the many kinds of galvanic battery may be used for generating the electric current; but, in this country, Daniell's battery is generally used, on account of the constancy and certainty of its action.

In all the earlier telegraphs, the stations were united by a continuous, insulated wire, which was brought back again to the battery from which it first started, so as to complete the circuit. The return wire is now always dispensed with, and the earth is made to complete the circuit. In the open country the telegraph wires are generally made of galvanised iron, and pass through earthenware insulators attached to high wooden posts. In large towns, where the posts would be inconvenient, copper wires covered with gutta-percha are used—several of them being put inside pipes placed underground, in the same manner as the pipes which are used for conveying gas and water. In submarine telegraphs, strong cables are necessary, consisting generally of copper wires embedded in gutta-percha and surrounded by galvanised iron-wire.

There are so many ways in which an electric current can be made to produce a set of signals, that it would be impossible, within the limits of this lesson, to describe the different forms which the *indicator* has been made to assume. But, however much telegraphic instruments may differ in their form and construction, they may be conveniently arranged under two heads—*Indicators* and *Recorders*. Indicating telegraphs are those which merely give passing signals to the observer or listener, most frequently by the movement of a pointer or indicator, technically called a *needle*. Recording telegraphs are those which permanently register their signals.

One of the simplest forms of the first kind is that known as Cooke and Wheatstone's Single-Needle Telegraph. The indicator of this telegraph has very much the appearance of a cabinet clock, with a magnetic needle resting vertically, and pointing to where the figure XII would be on a clock-face. By a simple contrivance, this needle can be *deflected* or turned by the electric current, either to the right or left, at the will of the operator. These deflections have been made to speak a language which is perfectly intelligible to the telegraph clerks. Thus, one deflection to the right signifies M; two to the left, A; one right, then one left, D; and so on. By using *two* needles the signalling can be done much more quickly, but a *double-needle* telegraph is a much more expensive instrument, because each needle requires a distinct wire, which costs from 8*l.* to 10*l.* a mile.

Sir Charles Bright invented a signalling telegraph which appeals to the *ear* instead of to the *eye*. A hammer is so placed that it can be made to strike either of two bells, one of which is muffled and the other clear. Messages can be signalled by these bells as fast as a clerk can write; and a person can *hear* and write much better than he can *see* and write.

Recording telegraphs are generally considered better than signalling instruments, because any errors in transmission can be traced to the party in fault. The simplest and best instrument of this kind is 'Morse's Register,' which is more extensively used than any other, particularly in the United States. Its signals consist of dots and dashes, which it makes on a strip of paper. The letter E is denoted by one dot; T by one dash; A by a dot and a dash, &c. It is said that 'an expert telegrapher can transmit from thirty to forty words a minute by this instrument, over a land-line of between 200 and 300 miles.'

This rate of transmission is not equal to that of the Telegraphic Printing Instruments now in use between London and Newcastle, Edinbugh, Manchester, and Glasgow. These instruments can *print* messages at the rate of from 70 to 120 words per minute! The transmission of an ordinary message from London to India occupies about ten minutes.

Some years ago there were 150,000 miles of telegraph wire being worked in different parts of the world; of which 15,000 were in Great Britain; 80,000 on the continent of Europe; and 48,000 in America. Some idea of the extent to which these lines are used may be gathered from the fact that in one year there were sent or received at the seven principal stations on one of our English railways, upwards of 170,000 messages on railway business alone, being at the rate of more than 465 messages a day. During the same period *one* of these stations had despatched or received nearly 3,000 messages for the accommodation of the public.

There is no doubt that before long the world will be girt round with an electric wire, connecting the principal cities and Courts. Let us hope it may be the means of 'banishing discord, and bringing about that happy millennium of peace and prosperity for which humanity is ever sighing.'

In concluding this lesson, it may be well to mention that the means of telegraphic communication throughout the United Kingdom, have been greatly facilitated by the purchase, by the Government, of the business of all the telegraphic companies in our country. The telegraphic service is placed under the control and management of the Post Office authorities, the result of this arrangement being that, for the small charge of one shilling, a message of twenty words is received at, and forwarded from, the nearest post office, as well as from the principal railway stations. G. H. G.

THE STEAM-ENGINE.

therm-o'-me-ter (Gr. therme, metron), *an instrument for measuring degrees of heat*

ex-pan'-sion (L. expando), *increase of bulk*

e-nor'-mous (L. ex, norma), *exceedingly great*

con-ver-ti-bil'-ity (L. con, verto), *the quality of being changed from one state to another*

tem'-pe-ra-ture (L. tempero), *the state of a body with regard to heat or cold*

e-co-nom'-ic-al (Gr. oikos), *frugal, not wasteful or extravagant*

gen'-e-rate (L. genus), *to produce, to form*

cir-cum'-fe-rence (L. circum, fero), *the line bounding a circle*

di'-a-gram (Gr. dia, gramma), *a figure drawn for the purpose of illustration*

com'-pli-ca-ted (L. complico), *made up of a great many parts*

pro'-cess (L. procedo), *operation, a series of actions*

vac'-u-um (L.) *empty space*

ma-rine' (L. mare), (a.), *relating to the sea*

pro-pel' (L. propello), *to drive forward by force*

lo-co-mo'-tive (L. locus, moveo), *having the power of moving from place to place*

sta'-tion-a-ry (L. sto), *fixed, not moving from place to place*

al'-i-ment (L. alo), *food, nourishment*

mal'-a-dy (L. malus), *sickness or disease*

al-ter'-nate (L. alter), (a.), *by turns, one after the other*

o-rig'-i-nal-ly (L. origo), *from the beginning, at first*

When water is heated to 212 degrees of Fahrenheit's thermometer, or 100 degrees of the Centigrade thermometer, it *boils*, that is, it flies off in the form of *vapour* or *steam*. Under the ordinary pressure of the atmosphere, water can never be heated beyond this point, for a greater amount of heat serves only to drive off a larger quantity of steam. A *cubic inch* of water produces about a *cubic foot* of steam, so that the volume or space occupied by steam is about 1728 times greater than that of the water which produced it. It is this *expansion* of a small quantity of water into a large volume of steam, which confers upon the latter its enormous force, and renders it so valuable as a source of mechanical power. When one cubic inch of water is converted into steam, it yields a mechanical force sufficient to raise a weight of one ton to the height of one foot.

Another most valuable property of steam, of which advantage has been taken in the working of steam-engines, is its convertibility from the state of *vapour* to that of a *liquid*, on the application of cold. If the temperature of steam be reduced below the boiling point of water, it again assumes its liquid condition; that is to say, a *cubic foot* of steam will be *condensed* by cold into a *cubic inch* of water, leaving a *vacuum* of upwards of seventeen hundred cubic inches.

A third and most important mechanical property of steam has yet to be noticed, and that is its *elasticity*. In consequence of this property, it tries to escape from any vessel in which it is confined; and, for that purpose, it presses upon the interior surface of the vessel with a degree of force which is dependent on the temperature under which it is generated. The higher the temperature the greater the elastic force. Thus, at 212° Fah., steam exerts a pressure of 15 lbs. on every square inch of surface; but at 250° the pressure is doubled; at 275° it is trebled; and so on, the elastic force increasing in a much greater ratio than the temperature. When the pressure does not exceed 30 lbs. to the square inch, it is called *low-pressure* steam, and the machine in which such steam is used is termed a *low-pressure* or *condensing* engine. In a *high-pressure* or *non-condensing* engine the elastic force of the steam varies from 35 lbs. to 90 lbs. to the square inch. All steam-engines, however much they may differ in their construction and mode of working, belong to one of these two classes.

It is impossible, within our present limits, and without the aid of diagrams, to give a detailed explanation of such a complicated machine as the steam-engine; but a knowledge of the preceding properties of steam will enable us to understand the leading principles of its action.

The non-condensing engine is the most simple in its construction, but the least economical in its working. The steam is generated in a *boiler*, from which it rushes through a pipe into the *cylinder*, which is a round, hollow vessel, something like a barrel in shape, but having its inner surface of exactly the same circumference from one end to the other. In this cylinder works an iron box, or plug, called the *piston*, which exactly fits the cylinder, so as to be steam-tight. The steam enters the cylinder at two openings, one at the bottom and the other at the top. When it enters at the lower opening it drives the piston upwards to the top; and when it enters at the upper opening it forces the piston downwards to the bottom again—the steam in both cases *escaping into the air* as soon as it has done its work. The piston is so connected with a series of rods, cranks, and wheels, that its alternate upward and downward motion moves the machinery.

The low-pressure or condensing engine differs from the above principally in the mode of withdrawing the used steam from the cylinder. As soon as the steam has driven the piston upwards, it is withdrawn by means of an air-pump (worked by the engine itself) into a separate vessel below, called the *condenser*. Here it is condensed by a squirt of cold water, and runs off into a cistern, from which the engine pumps it in a warm state into the boiler to make new steam. The same process takes place with the steam which forces the piston downwards, a vacuum being left behind in each case.

The amount of work which a steam-engine is capable of performing is usually expressed as being equal to the power of so many horses; but if the work now performed in Great Britain by steam-engines had to be done by horses, we should require about 2,000,000 more of those animals. It has been calculated that eight persons could live on the produce of as much land as is required to support one horse; so that the necessary food for these additional horses would require as much land for its growth as would sustain a population about five times as great as that of Scotland! Nor would the work be so well or so cheaply done. For instance, no number of horses could do the work of a *marine-engine*, in propelling a ship across the ocean; neither could horses take passengers and parcels from London to Manchester in six hours, as the *locomotive-engine* does every day. There are many other kinds of work for which horse-power is not at all adapted, but which a *stationary* steam-engine performs admirably; for, to use the words of an elegant writer, the steam-engine 'is equally active in all climates, and will do work of any kind: it is a water-pumper, a miner, a sailor, a cotton-spinner, a weaver, a blacksmith, a miller, &c.; and a small engine, in the character of a steam pony, may be seen dragging after it, on a railroad, a hundred tons of merchandise, or a regiment of soldiers, with thrice the speed of our fleetest horse-coach. Its aliment is coal, wood, charcoal, or other combustibles; it consumes none while idle; it never tires, and wants no sleep; it is not subject to malady, when originally well made; and only refuses to work when worn out with age. Yet, with all these talents and qualities, and, even when exerting a force equal to hundreds of horses, it is obedient to the hand of a child. It is, in fact, the king of machines.'

G. H. G.

JAMES WATT.

at-trib'-ut-ed (L. attribuo), *ascribed to, imputed to*
ex-pend'-i-ture (L. expendo), *cost*
ex-em'-pli-fied (L. exemplum), *to illustrate by example*
ef-fect'-ed (L. efficio), *produced*
com-par'-a-tive-ly (L. comparo), *by comparison*
count'-er-poise (L. contra, Fr. peser), *equivalence of weight*
ac-quir'-ed (L. acquiro), *gained, obtained*
math-e-mat'-i-cal (Gr. mathema), *pertaining to mathematics*
e-mer'-gen-cy (L. emergo), *a sudaen occasion*
pre'-cinct (L. præcingo), *an outward limit, a boundary*
rem'-e-dy-ing (L. re, medeor), *curing, making reparation*
vac'-u-um (L.), *empty space*

It has often happened in the history of the world that an important invention or discovery has been made very many years before any great benefits have resulted from it. This is to be attributed to two chief causes—the first of which is that a further invention is often required to enable us to derive advantage from the former; and the second is that what we call 'discoveries' are usually accidental, and require much careful study and perhaps a large expenditure of money to make them generally useful.

This is most fully exemplified in the case of the steam-engine; for although the expansive force of steam was observed in very early times, and the steam-engine was in use before the subject of this brief memoir was born, yet it was left for him to improve it by his various inventions so as fully to develop its capabilities.

Nearly 300 years B.C. lived Hero of Alexandria, a famous philosopher who has left us various scientific works, in one of which he describes an apparatus for raising liquids by the pressure of heated air, and also a machine for causing motion by the expansive force of steam. But he does not claim these as his own inventions, and therefore it is quite possible that they were known many years before his time. Truly, there is nothing new under the sun! It is not my purpose now however to tell you the various stages of progress which the steam-engine underwent down to the time of Watt, but to give you a brief account of his life, and of some of the improvements which he effected.

James Watt was born at Greenock, January 19, 1736. His father, a man of considerable talent, was a shipbuilder, engineer, shipchandler and merchant, and yet in spite of, or perhaps in consequence of, his carrying on so many different occupations he appears to have been a comparatively poor man. 'Jamie' was a delicate child, and in consequence received most of his education at home, for his school-fellows, thicker of head and stronger of limb, used to torment him on account of his quiet and thoughtful ways. He very early showed a taste for practical mechanics and experiments in science, and with a small electrical machine of his own making occasionally startled his young friends. His father gave him a set of small tools, such as carpenters use, and of course 'Jamie' was delighted. He took all his toys to pieces very carefully and then put them together again. When he was tired of this he invented new ones. His powers of invention, however, did not display themselves in this direction alone, for his cousin, Mrs. Campbell, tells us that when he was about thirteen years of age, his mother took him to stay with a friend of hers in Glasgow, his brother John accompanying them. On her return to Glasgow a few weeks later, her friend said to her, 'You must really take your son Jamie home; I can't stand the state of excitement he keeps me in. I am worn out with want of sleep. Every evening before 10 o'clock, when it is time to go to bed, he contrives to engage me in conversation, then begins some striking tale, sometimes funny, sometimes sad, but we all become so interested that we listen to him with breathless attention. Hour after hour strikes, and still he goes on. His brother John scolds him and pulls him by the arm, saying, ".Come to bed, Jamie; you are inventing story after story, to keep us with you till after midnight, because you love company and can't get to sleep for the toothache."

Yet, at this period of his life, his mind was intent upon thoughts which in after years produced important fruit. One evening he was sitting with his aunt, Mrs. Muirhead, at the tea-table, and offended the good lady very much by his apparent idleness and inattention to her. 'James Watt,' said she, 'I never saw such an idle boy; take a book and employ yourself usefully. For the last hour you have not spoken one word. You have done nothing but play with that tea-kettle, taking the lid off and putting it on again, holding now a cup and now a silver spoon over the steam as it comes out of the spout, and noticing the drops of water that are formed. Are you not ashamed of wasting your time in this way?'

Between this period and the age of nineteen he acquired some knowledge of mathematical instrument making, and then went to London to perfect himself in that art, riding on horseback in the company of a friend all the way from Scotland, a journey which took them twelve days to perform. He there apprenticed himself for a year to Mr. Morgan, in Finch Lane. He was very industrious and attentive to his business, and very frugal too, living on the modest sum of eight shillings a week, for his father at this time was in very poor circumstances. At the end of the year, having learnt as much of his business as most young men did in four or five, he returned to Scotland and tried to establish himself in Glasgow, but not being a burgess he was not suffered to carry on trade within the bounds of the city. In this emergency the professors of the University there, who had previously employed him in repairing and fitting up some of their scientific apparatus, gave him a helping hand and allowed him a shop within the precincts of the college, conferring on him the title of 'mathematical instrument maker to the University."

Here he carried on his business for six years, winning, by his intelligence, industry, and amiability, the friendship alike of professors and students.

He then took a shop in the city, and, besides carrying on his regular business, made organs and other musical instruments, invented several curious and useful machines, and acquired great skill as a civil engineer.

In 1763 he turned his attention to the defects in existing steam-engines and the means of remedying these defects. It happened that the University of Glasgow possessed a 'working' model of Newcomen's atmospheric engine, which would not 'work.' Watt was directed to repair it. He set it right, and it is still preserved as one of the greatest treasures the University possesses. Now you must know that, in this kind of engine, steam was introduced into the cylinder below the piston while the piston was drawn up by the descent of a counterpoise; a jet of cold water was then injected into this part of the cylinder, which condensed the steam, leaving almost a vacuum; the pressure of the external air then forced the piston down, the piston was raised again, fresh steam being introduced, and so motion was caused. But Watt, while experimenting with this, observed that much steam was wasted, and that the condensation was at the same time imperfect. In seeking for the cause of these defects and means of remedying them he went to the root of the matter, working scientifically from the outset, being the first enquirer into the action of the steam-engine who did so. He studied the laws of the pressure of air and steam, the quantity of steam which a given amount of heat would generate, and the amount of cold water required to condense this steam. Then he studied the pressure that would be produced by a given quantity of steam at a given temperature, and thus arrived at certain principles which he carefully recorded and employed in the construction of a steam-engine, for which he obtained a patent in the year 1768. By these inventions better work was obtained from the engine and with less expenditure of fuel than before—about three-elevenths of that which was formerly consumed by the best engines being saved.

In 1775, he met with Mr. Matthew Boulton of Birmingham, who became his partner. They took premises at Soho, in Birmingham, and with the money furnished by Mr. Boulton the manufacture of steam-engines under Mr. Watt's patent was carried on for many years, both partners realizing large fortunes by the undertaking. Still Watt went on making improvements. In 1782 he patented a double-acting engine, the first which gave rotary motion to machinery. In 1784 he invented and published various other improvements, among the more important of which were the *governor* for regulating the supply of steam, the *throttle valve*, a *counter* for recording the number of strokes, and also a locomotive-engine. This last, however, was not put in practice. In all essential particulars the steam-engine is now just what this famous inventor made it.

James Watt's mind was versatile as well as powerful. He was a man of mark in science, literature, and art, employing his leisure in various useful pursuits. The greatest chemical discovery of the age, viz., that water is composed of oxygen and hydrogen, is due to him. He communicated this important discovery to the Royal Society of London in 1783. Cavendish, one of our most celebrated physicists, discovered the same fact about the same time, but he did not publish it till 1784.

Watt, while on a visit to France in 1787, learned the use of chlorine in bleaching, and communicated it to his father-in-law, Macgregor, who first practised it in Britain. He also discovered that one cubic inch of water forms, when evaporated, a cubic foot of steam.

His last years were spent in great honour and happiness, and he died August 19, 1819, at Heathfield, near Birmingham, in his 84th year.

A statue to his memory, by Chantry, the sculptor, with an inscription by Lord Brougham, was placed in Westminster Abbey about five years after his death.

E. T. S.

DRAINAGE AND IRRIGATION.

fig'-u-ra-tive-ly (L. figura), *by a figure, not literally*
vol'-un-tar-i-ly (L. volo), *of one's own will*
pen'-ury (L. penuria), *poverty*
in-ter-pose' (L. interpono), *to place between, to interfere*
con-tra-ri'-e-ty (L. contrarius), *opposition*
com'-pli-ment (L. compleo), *an act or expression of civility*
ap'-er-ture (L. aperio), *an opening*
in-ter'-sti-ces (L. inter, sto), *a space between things*
cor'-o-ner (L. corona), *an officer who enquires into the cause of any accidental or violent death*
ir-ri-ga'-tion (L. irrigo), *the act of watering*
im-mov'-a-ble, (L. in, moveo) *that cannot be moved*

'Help me out of the ditch!' groaned Farmer Despond, who was figuratively dubbed by his neighbours a 'Stick-i'-the-mud'; and there he stood as immovable as though he had been pegged down to prevent his being blown away by the keen winds that whistled about his ears.

Standing in a ditch, with arms extended like those of guide-posts, or as a scarecrow (which latter is seldom worth the trouble of construction, as I have frequently seen a black-robed crow chattering over a banquet of worms under one of these ragged dummies), is not one of the most delightful of modern amusements. Like thousands of men and women who figuratively grope in a ditch all the way from the cradle to the grave, crying to every passer-by to help them out, Farmer Despond considered it one of the most princely of virtues thus to tread in the footsteps of his father who had made this practice a life-long philosophy. Farmer Despond was a grumbler of the old school; his neighbours throve while he was chained down to penury, his crops never yielded as other men's, his rent was never ready at the proper time, and he reviled Luck for always skipping over his farm when visiting that part of the country.

'Despond,' said I, 'I'll help you out of this ditch, and will point the way out of another. You are an honest, hard-working, well-disposed, but rather crotchetty fellow; you have as good a farm as any of your neighbours——'

'Nay,' he responded, with the air of a special pleader; 'I'll not stand that.'

'But, my good fellow, you are mistaken; and although you are even more industrious than some of your friends who appear to walk on pleasant paths, you are constantly groping in a ditch; your industry is a high virtue, but while it is put into a wrong channel, you can no more succeed in life than you can get corn out of old thatch, or obtain bloom and fruit by watering a dead stake.'

These few compliments on his industry woke Despond up, and on arriving at his homestead I commenced my harangue on the various subjects of husbandry at which he daily laboured but little understood. Referring first to the philosophy of *Drainage and Irrigation*, I said, 'Now, my good friend, your much-admired window-plants look as strong as five-barred gates, and gorgeous as rainbows. Just turn one of the flower-pots bottom upward. Ah! I see through a hole in the pot a heap of crocks and broken pots inside, which cannot be intended for manure. Exactly! You own that the water which is put in at the mouth of the pot must have the chance of running through, or it will go sour. You remember stifling a nest of wild bees the other day by blocking up the cavity in the bank to stop the access of air; also, how Mrs. Absent's child smothered itself with the bedclothes while its mother was out gossiping. Now, what would be the fate of your fine window-plants if you choked up the flower-pots and stopped the drainage? The earth is composed of small particles which do not form a *solid* mass, but which are like small pebbles with little spaces intervening. These small interstices between the grains of soil are charged with air, on which the roots of plants feed while threading their way through these little spaces. Now, if you put your head in a pail of water, and keep it there for some time, there'll soon be a case for the coroner; for, as you cannot inhale the air through the water, your breathing machinery will soon be stopped. Just so with the soil; if it is densely charged with water, air cannot permeate it, and the roots cannot feed. If the roots required water they might thrive in the old pond in the cow-close; but, as they only want *moist air*, only so much liquid as will make the air-spaces in the soil damp will benefit them, and the rest must have means of draining away, as is proved by your well-drained window-plants flourishing so well. Now, my good neighbour, why not treat your fields as large flower-pots? You have ditches all round to carry off the surplus water, which is about equal to pricking a hole the size of a pin's head in one of your flower-pots—only a small portion of the water can drain into the ditches before the air-cells of the fields are partially choked. Some farms have a light gravelly soil, through which the water will run as through a riddle; but yours being of clay, the particles are packed so closely together that the liquid can scarcely find its way out. Therefore, as there are no crocks or fragments underneath, as you have in flower-pots, it is necessary to do as some of your neighbours have done—lay down earthenware pipes with the narrow end of one put into the broad end of the other, making a long tube like the gas and water pipes they have in large towns; the water will "soak" through these soft clay pipes which stretch across the field, and will be emptied into the ditches to be carried away to the brook. Thus, you will have moist air-spaces instead of stagnant water, and your crops will rival those of your neighbours.

'Now for a few words on *Irrigation*. Your cucumber plants on the dungheap are dying as surely as the larks are singing overhead; for, while your fields have too little drainage, that heap has too much, or, rather, is not sufficiently supplied with moisture; and the plants are dying of thirst, as your last hatch of chickens did when you left them too long without water. The rain which falls on the heap drains rapidly out of the sides, and does not remain long enough to keep the air-spaces damp; therefore, the roots of the plants are parched for want of artificial moisture. That very heap illustrates the hill-side yonder—the water runs down rapidly and the ground thirsts for more. Now that your fields are to be drained it will be well to ask your landlord to provide the means of supplying the land with water from the mill-dam or the river behind the farm; for, if a long dry season comes, the air-spaces of the earth may be too dry, and your crops may be scorched. You noticed how Farmer Thrivewell's grass was *irrigated* or *flooded* in that way last summer, while yours gasped for moisture. No doubt that by paying a little extra rent as interest on the cost, you may induce the squire to lay out the necessary money to assist you. You see, that while you have too much water at one time and too little at another, your neighbours can regulate matters to suit the season. God has given abundant means of success—our business is to utilise them. Think over what I have said, and I'll come to-morrow for a little chat on other important matters.' E. H. B.

VARIETIES OF SOILS AND MANURES.

fer′-til-is-er (L. fero)	*that which makes fruitful*
per-fu′-mer-y (L. per, fumus)	*scent, that which emits odour*
rid′-i-cule (L. rideo)	*to laugh at with contempt*
fra′-grance (L. fragrans)	*sweetness of smell*
hus′-band-ry (S. hus, ban)	*tillage, frugality*
nu-tri′-tion (L. nutrio)	*the act or process of nourishing*
con-stit′-u-ent (L. constituo)	*an essential part*
trum′-per-y (Fr. tromper)	*empty talk, useless matter*
pe-cu′-li-ar-ly (L. peculium)	*particularly, singularly*

‘Good morning, neighbour! I see your waggoner is bringing a fine stock of manure up the lane; but it seems to me a thousand pities to buy an old second-hand smock to work in, and to give a good one away to the rag-dealer. You don’t seem to understand me. I mean this: you buy manure from neighbour Prudent, whose farm is exactly the same size as yours, and his cattle even fewer, while he has enough to produce good crops, and a surplus which he turns into money. I want to show that you are throwing away the best fertiliser in the world, and buying some of less value. You’ll think I’m like a jackdaw fighting over corn which is not my own, and pulling to pieces that which I’ve not helped to build; but, as I ’ve made up my mind to get you out of the ditch, you know, I must pull in my own way. I have a very keen nose, and if I had not seen your farmyard, I should nevertheless have discovered a fine bazaar of perfumery. Talk of “Araby the blest;” it’s not blest with a tithe of the fragrance hovering about Farmer Despond’s premises!

‘You told me, last year, of a discovery you had made—that a hundredweight of manure from your fowl-pen went almost as far as a quarter of a ton of that out of the farmyard; now, I want to explain how this comes about, for it's a grand text to preach upon, especially to a man like you, whose life has been spent in ridiculing what you call "new-fangled notions." Urine, it should be understood, is about five times as rich in fertilising materials as solid dung; hence it is that fowl-dung, which contains all the urine of the birds, is so powerful. Your stables and cowsheds have gutters for conveying all the liquid manure into that pool at the corner, but nothing of the kind is provided in the fowl-pen. As birds pass no urine, they furnish nothing but solid dung, from which fact you may get at the conclusion that the material which you waste in the form of liquid manure is in round numbers five times as powerful as the solid parts which you preserve, and that accounts for the fact that one hundredweight of fowl-dung did nearly as much service as a quarter of a ton of that out of the farm yard. John Prudent knows this, and consequently puts on his land material similar to that which you waste, and sells you a portion of the solid matter from his stables. Don't you see from this that while you are spending 10*l.* with him you are also wasting 50*l.* worth of most useful material, and thus suffering a loss of 60*l.*? This fragrance, which reminds you of a druggist's shop, is the identical stuff (ammonia) which chemists sell in the form of smelling-salts, and is one of the best fertilisers we can possibly get. You seem to stare when I talk about chemistry in connection with husbandry, but you may rely upon my statement that "new-fangled notions" will beat stupid men into the workhouse. I noticed when your last pig was killed how carefully you preserved the blood for manure, as though it were as valuable as diamonds; but I'll be bound you could not tell me why it is so valuable, except that you had heard as much. Do you know that blood contains a large amount of sulphur—a chemical property which enters largely into all plants; hence the high fertilising powers of that crimson fluid. Do you know, also, that vegetables are valuable for animals in proportion to the sulphur they contain, it being absolutely essential for nutrition? Now, bear in mind, the air cannot contain any substances holding sulphur, except very faint traces in what chemists call "sulphuretted hydrogen;" therefore the soil alone must furnish it to the roots. You probably wonder why sulphur and ammonia are not mixed together and used as manure; so they can be, and are, but I don't intend to trouble you with a detailed scientific lecture just now, as I want you first to understand general principles. Then there are other constituents of manure, such as soda, potash, lime, magnesia, phosphorus, &c., all of which are necessary, and without which plants could not grow. Manures from different kinds of animals contain various proportions of these things, and different kinds of plants and animals also require to be fed in accordance with these distinctions. For instance, your brindled cow is very lean and unwell, and you don't know why. I'll tell you. You have been feeding her of late on nothing but turnips, potatoes, and mangold-wurzel, all of which are good in turn, but none of them will do entirely, as they contain very small traces of lime. When Betty milks the cow she takes phosphate of lime from the animal in the milk, and as you don't give her food containing phosphate of lime, the poor cow is extracting it from her own bones, and consequently becoming so weak that you'll soon have to pay a fee to the cow-doctor. You must at once give her a good feeding on clover or barley-straw, which abounds in salts of lime, and she'll soon look as fresh as a buttercup and as fierce as a threshing-machine. I want you to clearly understand that as animals cannot feed on materials which do not contain the elements of which they are made, so plants must be treated; and, consequently, we must study what to put into the ground as well as what to feed our cattle on. I see you have been covering your turnip field with lime, which is a mistake in the sense of supplying manure, for, as I just told you, turnips do not contain much lime, and are not nourished by it. It may be useful for a different crop next year, but that's another phrase for spending money in advance, and tying up your capital. True, it has its advantages in another way, but it is not a manure in itself for the particular crop you are about to grow, and so you are mistaken.

'I know it's difficult for a man at your time of life to begin study, but "Time is not tied to a post like a horse to a manger; it passes like the wind, and he who would grind his corn by it must set the mill sails." Nothing can be had without pains, except poverty and dirt, neither of which you want. You must give over grumbling at Luck if you would keep out of the ditch. I saw your wife exchanging a heap of bones for a trumpery ornament the other day; little did she think how much hay she was parting with. I tell you, Mr. Despond, that if you cover one of your grass-fields with a thin coat of bone-dust, you'll have such a crop of grass that will make the other fields look foolish. You've no idea to what good account some of the waste matter of a household can be turned. In fact, if you fail to supply plants and trees with the exact kind of stuff they want, your plants will turn to herbs, and your trees will cease to bear fruit. I venture to say that your vine, which has been getting worse year by year, is sulky for want of potash, and I'll cure it for you this year, just to convince you of the fact. There's one very good feature, however, in farmyard manure; it contains a splendid variety of chemicals for almost all sorts of plants, if you use it properly; but we'll leave this matter till another day.

'I have known some soils to furnish all the nutriment required from them for years without manuring, and others that will grow nothing but stones unless treated very peculiarly. In fact, soils *are* manures to some extent, for they contain different proportions of chemical constituents, and so require more or less added to them according to what they possess. From this you will easily see how desirable it is to thoroughly understand the tools with which you work, and also what I meant by saying it was "a thousand pities to buy an old second-hand smock to work in, and to give a good one away to the rag-dealer."'

E. H. B.

PREPARING THE SOIL.

in-ter'-sti-ces (L. inter, sto), *a space between things*
hom'-i-ly (Gr. homilos), *a discourse*
e-con'-o-my (Gr. oikos, nomos), *thrifty management*
dis-fig'-ure (L. dis, figura), *to change to worse form, to deface*
im-ped'-i-ment (L. in, pes), *a hindrance*
ex-tract'-ed (L. ex, tractum), *drawn out*
im-press'-ed (L. imprimo), *affected*
as-si-du'-i-ty (L. assiduus), *diligence, closeness of application.*
pro'-ces-ses (L. pro, cedo), *operations*
pul'-ver-ise (L. pulvis), *to reduce to dust or powder*

'How now, my friend? You perspire like a water-cart, which shows at least that you are not afraid of hard work—a good contrast to some men, who seem to imagine that they have a freehold of time, and never toil till they are driven to it by sheer poverty. I like your industry much, but must take the liberty of cautioning you against labouring in vain and for a wrong purpose. Come, now, leave the field, put the plough under cover, and stable the horses, or you'll do more mischief than a fox would in a poultry yard, for the ground is wet as thatch, and all your ploughing is worse than in vain.

'I know you won't require a homily on this subject, for a moment's thought will make the matter as plain as the clock on the village church. If you'll have patience for a few days, and get on with some indoor-work while the sun dries the ground, you can then turn over the soil and make it as friable as mealy flour, leaving plenty of air-spaces; whereas, if you plough in its present state, you'll convert it into dough, and make it fit only for mud-cakes, so that when it is dry, you'll have clods as hard as stones.

'I know you are a true lover of economy, but refusing to look facts in the face is as like folly as fourpence resembles a groat. I have been walking round some of your fallow-fields, and had the misfortune to scrape my shins by falling over a clumsy heap of old tree stumps which you spent some weeks in digging out of the ground a year ago. What a pity that ugly heap of rubbish is not made to turn in a profit, helped out by the removal of some other nuisances which disfigure your farm, like blots and scratches on the copy-book of a slovenly school-boy!

'Don't you perceive that gravel, lime-scraps, road-scrapings, sand, and ashes, are all calculated to keep the ground open, and assist in the work of drainage, and that to withhold these things is very similar to stopping up the holes in a riddle when you want to sift a mixed lot of rubbish? And are you not also aware that the burnt ashes from tree-stumps, rotten timbers which are always in your way, brushwood and loose sticks picked up from the road-side and out of the woods, make the best of manure, and tend to lighten the land and make it porous?

'Of course, these remarks would not apply to your brother's farm, his land being sandy, and conse quently light and porous; there's no need to burn any portion of it, nor to mix with it cinders, and gravel, and lime-scraps, for it would be like putting one foot in the mud to pull the other out. The soil on his farm is so porous that the rain runs through as fast as a trotting mare when her head is turned homeward, and the consequence is that he must exercise his common sense in just the reverse direction. While you need to make your ground lighter, he needs to make his stiffer, and by these opposite processes you will both have larger crops, finer cattle, and easier times.

'Now a few words on the turning of the soil. Just for experiment, yoke your horses, put the plough to their tails, and drive on your team. "Go on, Beauty; gee, Violet; woa! stop 'em!" There, the furrow you have made is scarcely deep enough to bury a rat in. What is the object of turning the soil over? It is to pulverise it, to break one part from another, to open the pores for the admission of air, and leave a free passage for the roots to creep about and to feed without impediment; and if you disturb the ground only a few inches in depth, while the natural tendency of the roots is to go twice as deep, you leave solid ground beneath to act as a stumbling-block. I am persuaded that it 's not on account of laziness, but sheer want of thought on your part.

Plough *deep*, while others sleep;
And you shall have corn to sell and to keep—

is a capital proverb, and the word *deep* is not the least important. I daresay you make no distinction in ploughing for tap-rooted vegetables, such as carrots, turnips, mangold-wurzel, &c., as compared with peas and beans which don't descend half as deep. But, depend on this, if you will persist in ploughing all alike, you had better put the ploughshare down very low, so as to break the ground to a good depth. The wisest owl in the church steeple knows nothing of greater value.

'I am afraid you don't harrow the ground sufficiently after ploughing, for I see a regular supply of that class of weeds which have running roots, such as cornbine and what is commonly termed "twitch." I know, of course, that weeds, like bad habits, will grow apace, even with the most careful watching; but a word in season on the importance of raking out these pests that interlace the ground with as much complication as that of a spider's web, may not be out of place. You see that not only do these roots spread about the air-spaces, and prevent those of plants getting a free course, but they positively feed on the very chemical properties required for the crop, and their tops, when out of the ground, choke the plants and prevent a free current of air playing among the corn and vegetables. Now, it is next to useless to tear these things out of the ground, and then leave them on the surface in the expectation that they will die, for they frequently take root afresh, and find their way down again as pertinaciously as a pedlar seeks admission to the cottager's home. And if you put them away in a heap to rot for manure, they still have the germs for reproduction, and will turn up, like the memory of a crime, some day or other. Consign them to your bonfire, along with the tree-stumps, and make short work of them; keep your land clean, well ploughed and pulverised, avoid turning it over in wet weather, disturb it to a good depth, keep it well drained and manured, and brighter days will be in store; you will thus do much towards abolishing the practice which has held your nose to the grindstone—that of giving two days' work for one, and paying forty shillings in the pound.' E. H. B.

GETTING IN AND MANAGING CROPS.

ap-par′-ent (L. appareo), *plain, not doubtful*
gloom′-i-ly (S. glomung), *sullenly, dismally*
un-u′-su-al-ly (S. un, L. usum), *not commonly*
bank′-rupt-cy (Fr. banc, L. rumpo), *the state of not being able to pay one's debts*
il-lu′-sions (L. illudo), *false show, error*
ac′-cu-ra-cy (L. ad, cura), *correctness*
dis-pel′-led (L. dispello), *driven away*
cav′-i-ty (L. cavus), *hollowness, a hollow place*
re′-gi-ment (L. rego), *a body of soldiers commanded by a colonel*
ce′-re-al (L. ceres), *pertaining to corn*
com-mis′-sioner (L. committo), *one empowered to act*
a-ban′-don-ing (Fr. abandonner), *giving up, forsaking*

'LAST year, Mr. Despond, you made wry faces, and looked gloomily enough to frighten a looking-glass, because half your wheat seed had failed. You can no more bring strong corn stalks up without sufficient room than you can make children strong and robust, when compelling them to lie four in a bed—they must have room and air. You see, when three or four stems are fighting which shall grow on the spot of ground intended for one, the weaker must be crushed by the stronger; and so it was in your case—the best seeds reared their heads and overshadowed their more puny fellows, and the consequence was that not more than one-half of the usual number succeeded in asserting the right to live.

'Now, I want you to take my advice next October. Instead of scattering your corn broadcast, by which practice you sometimes huddle half a dozen grains in one little cavity, and, perhaps, leave large patches without a single kernel, dibble the grains at regular distances of about three inches in the rows, and let the rows be—say—six inches apart; then you will run the roller over the ground, which will ensure all the seed being at about equal distances from the surface, and never mind about seeing your neighbours, at spring-time, with thick and bushy crops of green leaves while you have staring and gaping fields, for as sure as summer follows spring, you will have a regiment of cereal soldiers that will form a capital line of defence against the inroads of the Bankruptcy Commissioners. Then, again, see how much more easily you can walk among the corn in spring-time and "spud" out the nettles and thistles, dandelions and poppies, and all the other field communists whose sole delight it is to destroy their better disposed fellows.

'You must not forget to observe the necessity of changing the crops, for the earth and its manures teem with a variety of qualities. If you grow a crop of corn, you exhaust lime, phosphates, and such-like materials, leaving, in a great measure, potash and soda, magnesia, &c., comparatively untouched. These latter are so essential for potatoes and turnips, that the ground is almost as fertile for that class of crops as it was before the grain was sown, so that very little manure will be necessary. These, again, may be followed by clover, or peas and beans, and so the work of rotation goes on.

'I notice that you have adopted a wise plan by sowing clover along with barley, which saves a great deal of ground and manure, as the barley comes off before the clover is fairly rising into crop, and the latter is a long time in the ground; thus, you are getting two productions off the same field in one year. You have also shown wisdom in abandoning the sickle in favour of the scythe for mowing your corn, by which plan you cut nearer to the ground, and obtain longer straw. Come, your own practice shows that you are open to conviction, and that you are alive to the fact that there is room for progress in farming, as in other affairs of life; I am hopeful that the hints I have given will not be wasted.'

E. H. B.

BIRDS AND INSECTS IN RELATION TO AGRICULTURE.

ag′-ri-cul-ture (L. ager, colo), *the art of cultivating the ground*
ma-raud′-er (Fr. maraud), *a plunderer, a pillager*
prov′-en-der (L. provideo), *food for beasts*
re-mu-ne-ra′-tion (L. remuneror), *reward, recompense*
ul′-ti-mate-ly (L. ultimus), *at last, finally*
con-sec′-u-tive (L. consequor), *following in train, successive*
sym′-me-try (Gr. sun, metron), *beauty of proportion*
my′-ri-ad (Gr. murias), *ten thousand, any large number*
mis′-chie-vous (S. mis, Fr. chef), *causing, injury*
ex-ter-mi-na′-tion (L. extermino), *destruction*
im′-ple-ment (L. impleo), *an instrument, a tool*
re-pro-duc′-tion (L. re-produco), *the act of producing anew*
vi′-gi-lance (L. vigil), *watchfulness*
de-creed′ (L. decerno), *determined, appointed*

‘SPARROW-PIE for dinner, eh, Despond! Why, how's this? Oh, I see! you look upon small birds as your direst enemies, because they devour some of the food set apart for your fowls, and so you popped a few off with the gun. Well, it's not the most desirable thing in the world to grow food for winged marauders to make merry over; and I daresay you would rather go without the morning's music, that wakes you up at daybreak, than be the jackal for providing provender for thrushes, blackbirds, sparrows and finches. But you and I won't agree on this subject in all its details; for I believe your son, master Jack, whom you encourage in dragging birds' nests, and blowing handsome birds' eggs for threading on a string, to be doing more harm than you dream of. Did you see that statement in the newspapers the other day, to the effect that our friends in Canada had sent over here for a few thousand sparrows to be turned into their fields? You did? Well, what do you suppose to be their object? Certainly not merely to have the pleasure of shooting them, nor yet to have the fun of seeing them scared from one field to another by the yelling and hooting and clapping of a fat-faced lad sitting on a gate, at the remuneration of eighteenpence a-week!

'You are aware there are such disagreeable foes as caterpillars, grubs, wireworms, slugs, snails, ants, beetles, and a host of insects which abound by millions, and crawl about both day and night where human eyes never scan, and human hands can seldom reach. How do you suppose these marauders live? I will tell you. Every plant that grows, every ear of corn that rears his stately head, every flower that blooms, is in danger of being destroyed by insects of various tribes. If your turnips manage to survive the attacks of the turnip-beetle and are growing well, you may find, as you did last year, that about the end of July the leaves look sickly, and ultimately the plants die in large numbers. What is your enemy? Pull up a few plants and you will probably find the tap-root left in the soil, and the upper part cut in two just beneath the surface of the soil, the withered leaves alone being held in your hand. Your enemy will probably prove to be a fat ugly caterpillar of a dirty-greenish colour with a number of black spots on his back. I have known these destructive fellows to spoil three or four consecutive sowings in one season. This caterpillar is the larva of a very beautiful moth, and thousands of them are found in the ground till about November, destroying the roots of myriads of plants; they change to pupæ in the winter, and appear as moths in the following June. The best friends we have for destroying these mischievous insects are the rooks and starlings: so that though the starling steal the cherries, the blackbird and thrush the strawberries, the rook and the sparrow the wheat, the pigeon the barley, let them have their fling, or the insects will devour and hinder the cereals, roots, and fruits in ten times the quantity. To kill small birds is to destroy the pounds in order to take care of the pennies, for every bird will devour a hundred-fold more enemies to the soil than himself, having an instinct for tracing their eggs as well as their carcases.

'If all the small birds were destroyed, you might pack up your implements and retire from agricultural service. Killing one insect is the prevention of thousands being bred, and, consequently, our lovely birds save us from those horrid plagues of which we have read so much. Just for satisfaction on this point I will mention the fact that a gamekeeper, who recently shot a crow, was subjected to a homily on the subject, and was induced to open the craw of the bird, when he found a compact ball of animal matter which proved to be nothing less than an assemblage of 110 wireworms—a fact which tells its own tale and teaches a capital moral.

'Frederick the Great, king of Prussia, having an overweening fondness for cherries, once established a crusade against sparrows, some of them having dared to peck at his favourite fruit. A reward of six pfennings per brace having been offered, the war against sparrows was commenced and carried on so briskly, that in two years' time there were not only very few sparrows to be seen, but scarcely any cherries or other kind of fruit; for other birds had been frightened away by the very means taken to kill the sparrows, and the caterpillars had an unchecked feast on the foliage of the trees. Frederick the Great found out that a higher king than himself had decreed more wisely than he, and he soon found it necessary to import sparrows from foreign lands. As we are indebted to our field warblers for good crops and absence of insect plagues, let us rejoice in, and be thankful for, those

'Birds, the free tenants of land, air, and ocean,
Their forms all symmetry, their motions grace;
In plumage delicate and beautiful;
Thick without burthen, close as fishes' scales,
Or loose as full-blown poppies to the breeze.'

E. H. B.

LATIN ROOTS.

a, *ab*, *abs*, from, *a*vert, *ab*jure, *abs*tain
ad, to, *ad*apt
acidus, sour, *acid*
actum, to do, *act*, counter*act*
ædes, a house, *ed*ify
æquus, equal, un*equal*
æra, a remarkable period
æstimo, *estimatum*, I value, *esteem*, *estimate*
æternus, eternal, co*eternal*
ævum, an age, co*eval*
ager, a field, *agri*culture
ago, *actum*, I do, or act, *agent*
alo, *alitum*, I nourish, *ali*ment
alter, another, *alter*, *alter*cation
altus, high, *alt*itude, ex*alt*
amplus, large, full, *ample*
angulus, a corner, *angle*
anima, air, breath, life, the soul, *animate*
annus, a year, *annual*
ante, before, *ante*date
antiquus, ancient, *antiquate*
aperio, *apertum*, I open, *aperient*
appareo, I appear
apto, I fit, *apt*, ad*apt*
aqua, water, *aqueous*, *aque*duct
arbiter, an umpire, *arbitrate*
ars, *artis*, art, *arti*ficial
avidus, greedy, hungry, *avidity*
bene, well, *bene*volent, *bene*fit
binus, two and two, double, *bin*ary, cara*bine*
cædo, *cæsum*, to cut, to kill, con*cise*, ex*cise*
calamitas a calamity
calx, *calcis*, limestone, *calc*ined

capillus, hair, *capill*ary
capio, *captum*, I take, *cap*able
caput, *capitis*, the head, *capit*al de*capit*ate
caro, *carnis*, flesh, *carn*al
cado, *casum*, to fall, oc*cas*ion
cavus, hollow, *cave*, con*cave*
cedo, *cessum*, I go, I yield, con*cede*, suc*ceed*, suc*cess*
celo, *celatum*, I hide, con*ceal*
centrum, a point, the *centre*, *central*
centum, a hundred, *century*
certo, I contend, I strive, discon*cert*
certus, certain, as*certain*
cingo, *cinctum*, to gird, to surround, *cinct*ure, pre*cinct*
circum, round, *circum*ference, *cir*cuit
civis, a citizen, *civic*, *civil*
clamo, *clamatum*, I cry out, ac*claim*
claudo, *clausum*, to shut, clause, *cloister*
cœlum, heaven, *cel*estial
cognosco, *cognitum*, I know, re*cognise*
colo, *cultum*, I cultivate, *colon*y
colossus, a gigantic statue, *colossal*
communis, common, *community*
con, *col*, *cog*, *co*, with, together, *con*clude, *col*lect, *cog*nate, *co*operate
contamino, *contammatum*, I pollute, *contaminate*
continuo, I persevere, *continual*

contra, against, *contra*dict
cor, *cordis*, the heart, *cor*dial
corona, a crown, a garland, de*crown*, *coronal*
corpus, *corporis*, a body, *corporal*
credo, I believe, *cred*ible
cresco, *cretum*, I grow, *crescent*, in*crease*
crux, *crucis*, a cross, *crucify*
crimen, a crime, dis*criminate*, re*criminate*
cumbo, I lie down, re*cumbent*
cumulus, a heap, *cumulate*
cura, care, se*cure*, sine*cure*
curro, *cursum*, I run, *curricle*
curvus, crooked, *curve*
de, down, *de*ject, *de*scend
decem, ten, *decem*ber
delecto, *delectatum*, to please, *delect*able
deleo, *deletum*, I destroy, *dele*terious
densus, thick, close, *dense*, con*dense*
dico, *dictum*, I say, *dic*tion, pre*dict*, e*dict*
digitus, a finger, *digit*
diluvium, a deluge, ante-*diluvian*
dis, twice, asunder, *di*lemma, *dis*sever
dissipo, *dissipatum*, I scatter, *dissipate*
divido, *divisum*, I divide, de*vise*, sub*divide*
do, *datum*, I give, con*dition*
doceo, *doctum*, to teach, *doctor*, *doctrine*
docilis, teachable, *docile*
dominus, a lord, a master, *domi*nate
domo, I tame, in*domit*able
domus, a house, *dome*stic
dos, *dotis*, a gift, *dot*al, *dower*
duco, *ductum*, I lead, pro*duce*, intro*duce*, via*duct*, con*duct*
durus, hard, *dur*able, en*dure*
e, *ex*, out of, from, *e*ject, *ex*pel
emineo, I excel, *eminent*
ens, being, ab*sent*
eo, *itum*, to go, trans*it*
equus, equal, *equal*ise
esse, to be, *ess*ence, *ess*ential
examen, a trial, *examine*
excello, I excel, *excel*lent
exemplum, a model, a copy, *example*
experior, *expertus*, I try, *expe*rience
exter, foreign, *exterior*
extra, beyond, *extra*ordinary
extremus, uttermost, *extreme*, *extrem*ity
faber, a workman, *fabric*
facio, *factum*, I do, I make, *fashion*, ef*ficacy*
fallo, I deceive, *fallacious*, in*fallible*
fascino, *I fascinate*, fascination
fero, *latum*, I bear, I carry, con*fer*, inter*fere*, re*late*
festus, joyful, *fes*tive
figura, a shape, *figure*
fingo, *fictum*, I make, I form, *feign*
finis, the end, fine, con*fine*
fio, I become, bene*fit*
firmus, strong. af*firm*, con*firm*
fixus, fixed, impressed, pre*fix*
flecto, *flexum*, I bend, re*flect*, de*flect*
flagro, I blaze, flagrant
flos, *floris*, a flower, *flower*, *floral*
fluo, *fluctum*, I flow, *fluent*, con*fluence*
folium, a leaf, *foliage*
forma, a shape, *form*, de*form*
fors, *fortis*, chance, *fortuitous*
fortuna, *fortune*, *fortunate*
frango, *fractum*, to break, *fracture*, re*fract*
fragrans, *fragrantis*, *fragrant*
frequens, *frequentis*, *frequent*
frico, *fricatum*, I rub, *friction*
fugio, *fugitum*, I fly, *fugitive*, re*fuge*
fumus, smoke, *fume*, *fumigate*
fundo, I found, I establish, *founder*

fundo, fusum, to pour out, I melt, con*fuse*, in*fuse*
genus, a kind, *gen*der, *general*
germen, a bud, *germ*
gero, gestum, to bear, to carry, *gestat*ion, *gest*iculate
gigno, I beget, I bring forth, pro*geny*, *geni*al
gradus, a step, *grade*, *gradu*al
gravis, heavy, *grave*, ag*gravate*
gradior, gressum, to go, pro*gress*, e*gress*
grex, gregis, a flock, *greg*arious
guberno, I govern, *gubernat*ion, mis*govern*
habito, I dwell, in*habit*
hæreo, hæsum, I stick, ad*here*, in*here*
hæres, hæredis, an heir, co-*heir*, in*herit*
herba, a herb, *herbal*
hiberno, *hibernate*
hospes, hospitis, a guest, *hospit*al
hostis, an enemy, *host*ile
idem, the same, *ident*ify
ignorans, ignorantis, *ignorant*
imago, imaginis, *imagine*
in, into, *in*mate, *in*culcate, *in*, not, *in*nocent
industria, *industry*
iners, inertis, slothful, inactive, *inert*
ingenium, wit, contrivance, natural disposition, *ingeni*ous, *ingenu*ous
insto, I insist, *instant*
insula, an island, *insular*
integer, entire, *integr*ate
intelligo, intellectum, I understand, *intelligent*
inter, between, *inter*pose, *inter*fere
interpres, interpretis, *interpret*
intimus, innermost, *intim*ate
intro, within, *intro*duce
intus, inward
irrito, I make angry, *irritate*
jacio, jactum, to throw, e*jaculate*, in*ject*
jungo, junctum, to join, *junct*ion, re*join*
labor, labour, *labor*ious
laqueo, I ensnare, inter*lace*
lateo, I lie hid, *latent*
latus, broad, wide, *lat*itude
laxus, loose, *lax*, re*lax*
lego, lectum, to choose, to read, col*lect*, *lect*ure, *leg*ible,
levis, light, *levity*
lex, legis, law, *leg*al
liber, free, *liber*al
libra, a balance, de*liber*ate
linea, a line, de*lineate*
locus, a place, *local*ity, *local*
lucrum, gain, *lucr*e, *lucr*ative
ludo, lusum, I play, de*lude*, pre*lude*
lumen, luminis, light, *lumin*ary
lustro, lustratum, I purify, I enlighten, *lustrat*ion, il*lustrate*
luxus, excess, *lux*uriant
lympha, a colourless fluid, water, *lymph*atic
magnus, great, *magn*ify
major, greater, *major*ity
malus, bad, *mal*ady
mando, mandatum, I bid, I command, *mand*ate
maneo, mansum, I remain, per*manent*
manus, the hand, *manual*, *manu*facture
manifestus, plain, *manifest*
mare, the sea, *marine*
massa, a lump, *mass*, a*mass*
mastico, masticatum, I chew, *mastic*ate
materia, matter or stuff, *material*
maturus, mellow, ripe, pre*mature*, *mature*
medeor, I cure, *medic*al, irre*medi*able
medius, middle, *medi*ate
melior, better, a*melior*ate
membrana, the upper thin skin of anything, *membrane*

memor, mindful, *memor*able
mercurius, mercury, *mercurial*
mergo, *mersum*, I plunge, e*merge*
migro, *migratum*, I remove, *migrate*, e*migrate*
mille, a thousand, *millen*nium
minister, *ri*, a servant, ad*minister*
minor, *minatus*, I threaten, *men*ace
miror, *miratus*, I wonder, *mir*acle *mirror*
mitis, mild, *miti*gate
mitto, *missum*, I send, ad*mit*, com*mit*
modus, a measure, a manner, *mode*, *mod*erate
moneo, *monitum*, I warn, advise, ad*monish*
mons, *montis*, a mountain, a*mount*, dis*mount*
monstro, *monstratum*, I show, de*monstrate*
mors, *mortis*, death, *mor*tal, *mor*tuary
moveo, *motum*, to move, *motion*, pro*mote*
multus, many, *mult*itude, *multi*ply
munus, *muneris*, a gift, *munifi*cent, re*munerate*
nascor, *natum*, to be born, *natal*, in*nate*
natura, *nature*, *natural*
necessarius, *necessary*, un*necessary*
nex, *necis*, death, destruction, per*nicious*, inter*necine*
nihil, nothing, an*nihil*ate
noceo, *nocitum*, I hurt
nomen, *nominis*, a name, *nominal*, *noun*
norma, a rule, *normal*, e*norm*ous
nosco, *notum*, I know, *notion*, recog*nise*
noto. I mark, *note*, de*note*
nox, *noctis*, night, *nocturnal*
noxius, hurtful
numerus, number, *numeral*
nutrio, *nutritum*, I nourish, *nutri*ment
ob, *oc*, in the way, against, *ob*ject, *occur*
obliquus, sideways, *oblique*
ordo, *ordinis*, order, *ordain*, co*ordin*ate
origo, *originis*, *origin*, *origi*nal
oro, I pray, *oracle*
os, *oris*, the mouth, *or*al, *ori*fice
palpo, *palpatum*, I touch, *palp*able
pando, *pansum*, I open, I spread, ex*pand*
panis, bread, *pan*try
pareo, *paritum*, I appear, ap*pear*
paro, *paratum*, I pre*pare*, ap*parel*, com*pare*
pars, *partis*, part, a*part*, *parcel*
pastor, *pastoris*, a shepherd, *pastor*al
pectus, *pectoris*, the breast, *pector*al
peculium, money, private property, *peculiar*, *pecul*ate
pejor, worse, im*pair*
pello, *pulsum*, I drive, im*pel*, re*pel*, ex*pel*
pendeo, I hang, de*pend*, sus*pend*
penetro, *penetratum*, I pierce, im*penetr*able
penuria, extreme want, *penurious*
per, through, *per*ambulate
perpetuus, lasting, *perpetual*
pes, *pedis*, the foot, *ped*al, *pedes*trian
peto, *petitum*, I ask, *pet*ition
placeo, *placitum*, I please, com*placent*
plango, *planctum*, I strike, I lament, *plain*, com*plain*
pleo, *pletum*, I fill, com*ple*ment
plecto, *plexum*, to twist, to plait, per*plex*
plico, *plicatum*, I fold, im*plicate*, inex*plic*able
pluma, a feather, *plumage*
polluo, *pollutum*, I infect, *pollute*
pono, *positum*, I place, de*ponent*
portio, a portion, pro*portion*

porto, I carry, *port*able, im*port*
præ, before, *pre*cede
pretium, a price, ap*preciate*
primus, first, *prim*al, *prim*itive
privus, one's own, peculiar, *priv*ate, *priv*ilege
pro, for, forth, *pro*noun, *pro*ceed
probo, *probatum*, I prove, *prob*able
proles, *prolis*, offspring, *prole*tary, *proli*fic
proprius, one's own, *proper*, *proprie*tor
proximus, nearest, *proxim*ate, ap*proach*
pulvis, dust, *pulver*ise
punio, *punitum*, I punish, im*punity*
puto, *putatum*, I reckon, com*pute*
quæro, *quæsitum*, I ask, *query*, ac*quire*
qualis, of what kind, *qual*ity, dis*qualif*y
quatio, *quassum*, I shake, concussion
quatuor, four, *quad*rant, *quart*
radius, a ray, *radi*ate, ir*radi*ate
rapio, *raptum*, I snatch, rap, *rapt*ure
raro, seldom, *rare*ly
re, back, again, *re*call, *re*build
recens, new, fresh, *recent*
rego, *rectum*, I rule, *reg*ulate, *reg*ular
reciprocus, going, a flowing backwards and forwards, *recipro*cal
rectus, right, cor*rect*, *rect*itude
rigo, *rigatum*, I water, ir*rigate*
rodo, *rosum*, I gnaw, *rod*ent, cor*rode*
rota, a wheel, *rota*tion
rumen, *ruminis*, the cud of beasts, *rumin*ate
rumpo, *ruptum*, to burst, inter*rupt*, cor*rupt*
sal, *salis*, salt, *sal*ary
salio, *saltum*, I leap, *sal*ly, *sal*ient
sanctus, holy, *sanct*ify, *saint*
satis, enough, *satisfy*
scala, a ladder, *scale*, es*cala*de
scando, *scansum*, I climb, a*scend*, de*scend*
scio, *scitum*, I know, *science*, *scien*tific
scribo, *scriptum*, to write, a*scription*, de*scription*
se, aside, *se*duce
securus, safe, *secure*
sedeo, *sessum*, I sit, *seden*tary, *sedi*ment
sentio, *sensum*, to perceive, to think, *senti*ment, as*sent*
separo, *separatum*, I sever, I *separ*ate
sepelio, *sepultum*, to bury, *sepul*chre
sequor, I follow, con*sequence*, sub*sequent*
servio, *servitum*, I serve, *servile*
signum, a sign, a mark, *sign*ify, re*sign*
similis, like, *simil*ar, re*semble*
simplex, simple, *simplic*ity
simul, at the same time, *simul*taneous
sisto, *statum*, I stop, I stand, as*sist*, con*sist*
solidus, *solid*, *sol*der, con*solid*ate
solor, I comfort, *sol*ace, con*sole*
solus, alone, *sole*, *sol*itary
solvo, *solutum*, I loose, *solve*, ab*solve*, dis*solve*
sorbeo, *sorptum*, I suck in, ab*sorb*
specio, *spectum*, I see, con*spicu*ous, de*spise*
spiro, *spiratum*, I breathe, in*spire*, per*spire*
spondeo, *sponsum*, I promise, re*spond*, corre*spond*
stagnum, pool, *stagnant*
statuo, *statutum*, I set up, I appoint, *statute*
stinguo, *stinctum*, I put out light, ex*tingu*ish, di*stinct*
stipulor, I make a bargain, *stipulate*
sto, *statum*, I stand, *sta*ble, e*sta*blish

stringo, *strictum*, I hold fast, I bind, *strict*, *string*ent
struo, *structum*, to build, *structure*, con*struct*
stupeo, I am stupid, *stupefy*, *stupid*ity
suadeo, *suasum*, I per*suade*, dis*suade*
sub, under, *sub*altern, *sub*jugate
subter, beneath, *subter*ranean
sueo, *suetum*, to accustom, de*suetu*de
sufficio, *suffectum*, I am able or *sufficient*
sumo, *sumptum*, I take, as*sume*, pre*sume*
super, above, over, *super*able, *super*pose
surgo, *surrectum*, to arise, re*surrection*
tango, *tactum*, I touch, *tang*ible
tempero, *temperatum*, I mix, I moderate, at*temper*, dis*temper*
tempus, *temporis*, time, *temp*oral, con*temp*orary
tendo, *tensum*, I stretch, *tension*
teneo, *tentum*, I hold, *ten*able, *ten*ement, *tenet*
terminus, a boundary, *terminate*
terra, the earth, *terr*ace, in*ter*
torpeo, I am benumbed, *torp*id
traho, *tractum*, to draw, *tract*able, de*tract*
tranquillus, quiet, calm, *tranquil*
trans, across, *trans*mit
tribuo, *tributum*, to give, *tribute*, at*tribute*
tubulus, a little pipe, *tube*
ultimus, the last, utmost, *ultim*ate
ultra, beyond, *ultra*marine, *ulter*ior
unda, a wave, *und*ulate
unus, one, *union*, *unison*
urbs, *urbis*, a city, *urb*ane, sub*urb*
uro, *ustum*, I burn, combustion
vado, *vasum*, I go, e*vade*, in*vade*
vagor, I wander, *vag*abond
valeo, *valitum*, I am strong, *val*id, *val*iant
varius, different, *vary*
veho, *vectum*, I carry, *veh*icle
velox, swift, *veloc*ity
venero, *veneratum*, I worship, I honour, *vener*ate
venio, *ventum*, I come, con*vene*, inter*vene*
ver, *veris*, the spring, *ver*nal
vereor, I fear, re*vere*, ir*reverent*
vertebra, a joint in the back bone, *vertebrate*
vertex, *verticis*, the top of anything, *vert*icle
verto, *versum*, I turn, ad*vert*, in*vert*
vestis, a garment, *vest*ure, in*vest*
via, a way or road, de*via*te, ob*via*te
vibro, *vibratum*, I shake, *vibrate*
vicinus, a neighbour, *vicinity*
video, *visum*, I see, pro*vide*, pro*vender*
vigeo, I grow, *veget*able
vigil, watchful, *vigil*ant
vinco, *victum*, I conquer, in*vinci*ble, pro*vince*
vindex, *vindicis*, a defender, *vindic*ate
vir, a man, *vir*ile, decem*vir*
vito, *vitatum*, I avoid, ine*vit*able
voco, *vocatum*, to call, *vocation*, ad*vocate*
volo, I am willing, *vol*ition, *vol*untary
voluptas, *voluptatis*, sensual pleasure, *volupt*uary
voro, *voratum*, I de*vour*, *vora*cious, carni*vorous*
vortex, *vorticis*, a whirlpool, *verti*cal
votum, to vow, de*vote*
vello, *vulsum*, to pull, con*vulse*, re*vulsion*

GREEK ROOTS.

a, (ἀ), without, *a*pathy
agōn, (ἀγών), a contest, *agony*
aër, (ἀήρ), the lower air, *aër*ial
aither, (αἰθήρ), upper, purer air, *ethereal*
allelon, (ἀλληλών), one another, par*allel*
ana, (ἀνά), through, up, *ana*tomy
anti, (ἀντί), opposite, against, *anti*pathy
arche, (ἀρχή), beginning, sovereignty, an*archy*
astēr, (ἀστήρ), a star, *aster*isk, *astro*nomy
atmos, (ἀτμός), vapour, *atmos*phere
aulos, (αὐλός), a pipe, hydr*aulics*
authentes, (αὐθέντης), one who does a thing by his own hand or power, *author*
ballō, (βάλλω), I throw, *bal*ister, hyber*bole*
baros, (βάρος), weight, *baro*meter
boscō, (βόσκω), I feed, pro*boscis*
bussus, (βύσσος), bottom, depth, a*byss*
character, (χαρακτήρ), an impress, a mark or token, *characte*ristic
casma, (χάσμα), a yawning, a hollow, *chasm*
chronos, (χρόνος), time, *chronic*, *chroni*cle
dēmos, (δῆμος), the people, *dema*gogue
dia, (διά), through, *diabolical*
ek, *ex*, (ἐκ, ἐξ), out of, from, *ec*centric, *ex*orcise
elao, (ἐλάω), I drive, *ela*stic
electron, (ἤλεκτρον), amber, *electro*
emblema, (ἔμβλεμα), looking through, *emblem*
epi, (ἐπί), upon, *epi*taph
eros, (ἔρος), love, *ero*tic
ergon, (ἔργον), a work, en*ergy*
gramme, (γραμμή), a line, dia*gram*
gennao, (γεννάω), I produce, hydro*gen*
glupho, (γλύφω), I carve, hiero*glyph*
grapho, (γράφω), I write, *graphic*
guros, (γυρός), a circle, circum*gyrate*
hieros, (ἱερός), holy, *hier*arch
hodos, (ὁδός), a way, met*hod*, *exodus*
homalos, (ὁμαλός), equal, average, an*omalous*
homilos, (ὅμιλος), a multitude, *homily*
hudor, (ὕδωρ), water, *hydrop*sy, *hydro*gen
kentron, (κέντρον), a goad, a point, *centre*
konos, (κῶνος), *cone*, *conical*
krustallos, (κρύσταλλος), *crystal*
kulindros, (κύλινδρος), a *cylinder*
logos, (λόγος), a word, a discourse, *logic*, ana*logy*
luo, (λύω), I loose, ana*lyse*
mathema, (μάθημα), learning, science, *mathema*tics
mechanē, (μηχανή), a contrivance, *machin*ate
meter, (μήτηρ), a mother, a *matron*
metron, (μέτρον), a measure, *metre*, baro*meter*
murias (μυριάς), 10,000, *myriad*
musterion, (μυστήριον), a *mystery*
muthos, (μῦθος), a fable, *mythic*
narke, (νάρκη), torpor, narcotic
nomos, (νομός), a law, astro*nomy*
oikos, (οἶκος), a house, di*ocese* *church*
ops, (ὤψ), the eye, *optic*
organon, (ὄργανον), an instrument, *organ*
oxus, (ὀξύς), sharp, acid, *oxy*gen
para, (παρά), beside, against, *para*ble
pater, (πατήρ), a father, *pater*nal

pathos, (πάθος), feeling, *path*etic
peri, (περί), round, about, *peri*meter
petalon, (πέταλον) a leaf, *petal*
phaino, (φαίνω), I show, epi*phany*
philos, (φίλος), a friend, *phil*anthropy
phero, (φέρω), I bear, I carry
phos, (φῶς), light, *phos*phor
phren, (φρὴν), the mind, *fran*tic
phusis, (φύσις), nature, *phys*ic
polis, (πόλις), a city, *police*
polemos, (πόλεμος), war, *polemi*cal
pro, (πρό), for, forth, *pro*noun
scopeo, (σκοπέω), I look at, micro*scope*
sema, (σῆμα), a sign
sophos, (σοφός), wise, philo*sopher*
sphaira, (σφαῖρα), a ball, *sphere*
stasis, (στάσις), a standing, *stat*us
stratos, (στρατός), an army, *stratagem*
sun, (σύν), with, *sym*pathy
techne, (τέχνη), an art, *techn*ical
tecton, (τέκτων), a workman, archi*tect*
tele, (τῆλε), at a distance, *tele*gram
therme, (θέρμη), heat, *thermo*meter
trope, (τροπή), a turning, zoo*trope*
zoon, (ζοόν), an animal, *Zoo*logy

FRENCH ROOTS.

à, to, *a*dieu
abandonner, to *abandon*
aise, ease, un*easy*
ancien, ancient, *ancient*
artillerie, artillery, *artillery*
briller, to shine, *bril*liant
broder, to embroider, *embroidery*
brunir, to burnish, *burnish*
caparaçon, caparison, *caparison*
chef, the head, *chief*, a*chieve*
cru, grown, ac*crue*
développer, to develop, *develop*
en, in, into, *en*demic
envelopper, to envelop, *envelope*
garnison, garrison, *garrison*
gorge, the throat, dis*gorge*
hagard, haggard, *haggard*
harasser, to harass, *harass*
hausser, to raise, en*hance*
maraud, a rascal, *to maraud*
ouvrage, a work, *average*
peser, to weigh, *poise*
pris, taken, com*prise*
tromper, deceive, *trumpery*

SAXON ROOTS.

bannan, to proclaim, *banns*
banc, a bench, *bank*
beal, misery, *baleful*
buan, to inhabit, hus*band*
car, *care*
cursian, to *curse*
glomung, twilight, *gloom*
hus, a house, *hus*band
cearian, to take *care*
smoran, to *smother*

WELSH ROOT.

hap, luck, chance, mis*hap*

ARABIC ROOT.

kimia, the occult, or hidden art, al*chymy*, *chemistry*

Spottiswoode & Co., Printers, New-street Square, London.